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ON THE SURGICAL TREATMENT OF A MOST FREQUENT CAUSE OF DYSMENORRHEA AND STERILITY IN WOMEN[1]

BY PROFESSOR S. POZZI, PARIS

IT can be asserted that the most frequent cause of dysmenorrhea and sterility in women is a rather common malformation of the cervix uteri by which the os is unduly narrowed. This anatomical condition seems to be the result of a certain degree of arrest in development, for it generally coexists with shape or type of uterus very similar to the infantile type; the cervix is longer in proportion to the length of the corpus uteri than is the case normally and its axis is more or less bent on the axis of the corpus forming an anterior angle. Hence results a cervico-corporeal anteflexion of the uterus itself.

This condition is frequently met with in badly developed women of frail constitution. But it also can be observed in strong women, as a small and absolutely limited malformation, without atrophy of the organ.

Dysmenorrhea is then most often present, and it is in those cases that, in my experience, pains are most severe. Occasionally dysmenorrhea may be absent; but the almost universal result is sterility. Fecundation meets with several obstacles: (*a*) stenosis of the uteri; (*b*) the bend in the cervical canal at the level of the isthmus, producing flattening of the lumen; (*c*) difficulty in the drainage of the cervical mucus. This becomes the predominant factor both of dysmenorrhea and sterility, especially if a slight infection increases the secretion of mucus and modifies its qualities. The result is an accumulation of mucus in the cervical cavity which is soon dilated in assuming the shape of a small barrel. All forms of congenitally narrow cervix may present this abnormal stenosis sometimes comparable to a pin-hole, but more frequently it is met with cases of *conical cervix*.

The infecting agent may be the gonococcus, more or less attenuated, and the mucus may at first be frankly purulent. More often it is impossible to ascribe infection to the above germ: we are dealing then with slight attenuated infection: the mucus is hardly opalescent or even absolutely hyaline like melted glass. I am inclined to think that these are cases of simply saprophytic infection.

In this form of *cervical metritis due to stenosis* the predominant symptoms are leucorrhea and dysmenorrhea. In the chronic period leucorrhea is moderate and intermittent, flowing when the distended cervix empties itself of the accumulated mucus. Examination with a bivalve speculum often shows the os swollen and distended and when slight pressure is brought on its sides by means of the valves of the speculum, a considerable and unexpected quantity of accumulated discharge is seen to ooze out.

In long standing cases I have seen polypus vegetations, isolated or agglomerated in the cervical cavity. These are always cases of old and very intense dysmenorrhea.

[1] Read before the American Gynecological Society, April, 1909.

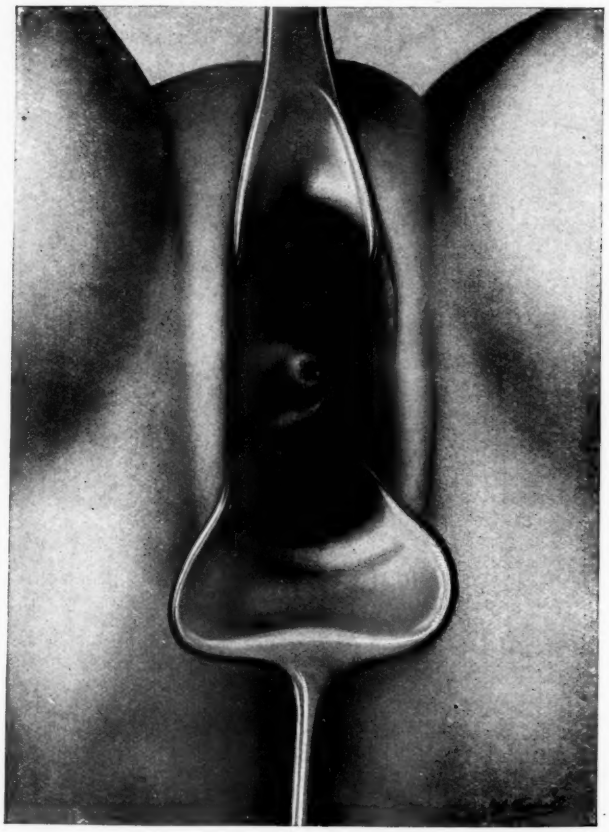

Fig. 1. Conical cervix. Punctiform orifice.

The indication for operation in this congenital cervical stenosis, especially when complicated by cervical metritis, is obviously to correct the bad anatomical condition which keeps up the trouble, viz: stenosis of the external os.

Here dilatation, whether gradual or forced, is insufficient and illusory on account of its ephemeral effect.

Bilateral section is not sufficient either and it is not without danger. I say that it is insufficient because its action has no certain duration. The angular healing of the two commissural incisions can give rise, more or less rapidly, to a renewed condition of stenosis. Moreover infection of the wounds may be brought about and carried, doubtless through lymphatics to the parametrium and adnexa. I have seen many cases of this kind where Sims' operation had been performed for dysmenorrhea and sterility caused by stenosis of the os: the result (owing to the production of lymphangitis) had been inflammation of the tubes; hence ensued the definite establishment of the very sterility which the operation was intended to cure.

So, we must try to perform an operation that will give a lasting result and that will not produce infection. Both these aims seem to be reached by the remodeling of the os externum, which I have invented and described under the name of *Stomatoplasty by commissural evidement.*

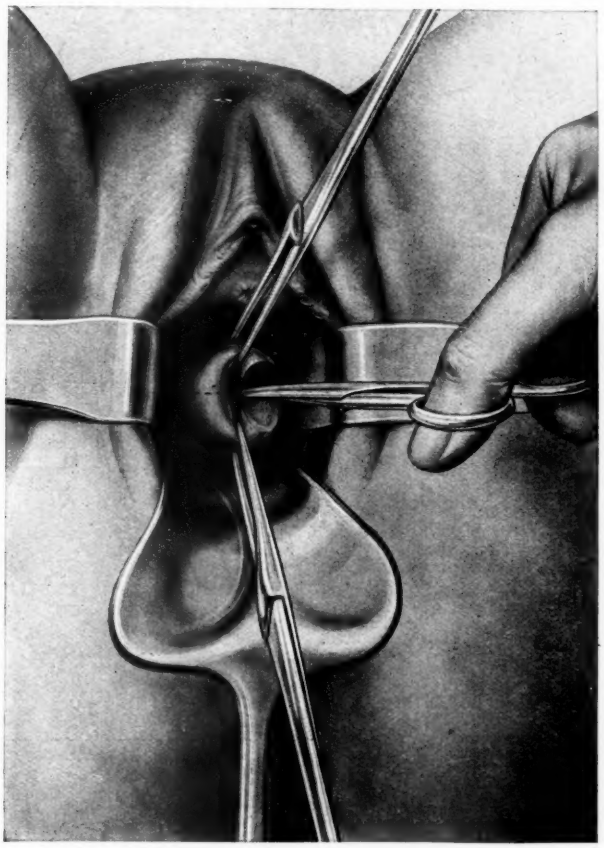

Fig. 2. Bilateral incision of the cervix.

TECHNIQUE OF THE OPERATION

A. Preliminary Dilatation and Curettage. The cervix of the uterus is first exposed by means of valves held back by assistants and is seized with great care, owing to the extreme narrowness of the aperture. A bullet forceps is next taken up and one of its branches passed through the orifice into the cervix when the other branch clasps the lower wall of the cervix, so the forceps immobilizes the lower lip.

Another bullet forceps is placed in similar fashion on the anterior lip.

(Sometimes the aperture is too small to allow a branch of the bullet forceps to pass. If such should prove to be the case, then the aperture must be increased by two small lateral cuts.)

Straight scissors are next required to proceed with the bilateral discission of the cervix, in a length of two or three centimeters.

Similar section is made on the other side.

Next comes the progressive dilatation of the cervical canal with Hegar's probector bougies; these may be used easily up to No. 20 or 30, owing to the preliminary bilateral section.

I always perform the curettage, even the exploratory incision. I follow up currettage with an intra-uterine aseptic flushing, secondly, an injection of perchloride of iron, and thirdly, another aseptic injection. I then perform the principal operation on the cervix.

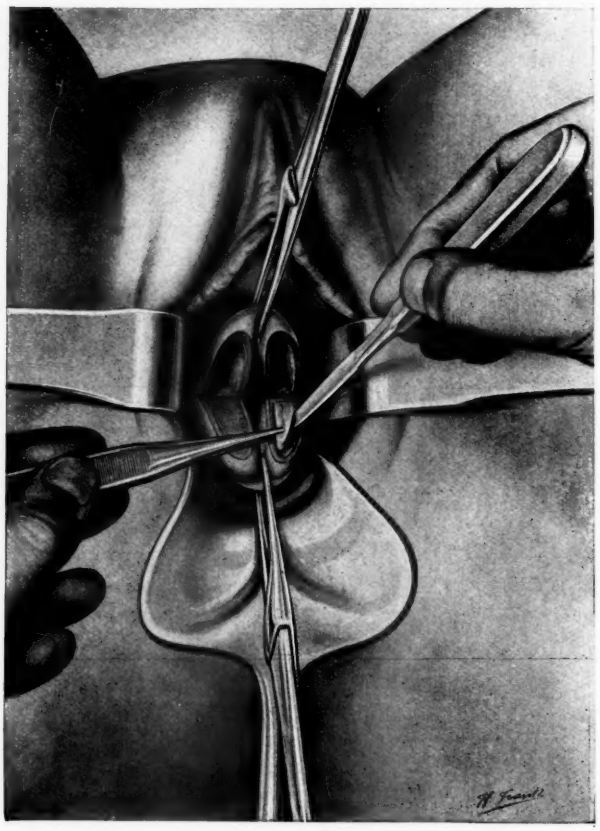

Fig. 3. Hollowing out of the cut surfaces of the cervix.

B. Stomatoplasty. First Stage. Owing to the bilateral incision made at the beginning of the operation, the cervix is divided by halves: one half anterior and superior, the other posterior and inferior.

This first stage is something like the bilateral incision of the cervix, in Sims' operation.

Second Stage. Each half of the cervix is now seen divided into three surfaces: one median and two lateral. The median is formed by the mucous groove, the two lateral, of a triangular shape, are the bleeding surfaces of the section.

If now, acting as did Sims, we were to leave these surfaces to heal freely, cicatrization of the divided part could be partially established and the result would be negative.

To prevent this, I conceived the idea of uniting the internal cervical mucous membrane with the external cervical mucous membrane, but as neither of them are sufficiently extensive to cover up the bleeding triangular surfaces, I found it necessary to cut out a strip of tissue between them.

Plate 3 indicates how this hollowing out or evidement should be done:

With a sharp pointed knife an incision is made along each side of the bleeding triangular surfaces, the knife cutting obliquely from top to bottom, so that, in its depth, each section goes to meet the other. Four strips are thus cut off, two on each half of the divided neck.

Of course, this is the most delicate part of the operation, and requires great care.

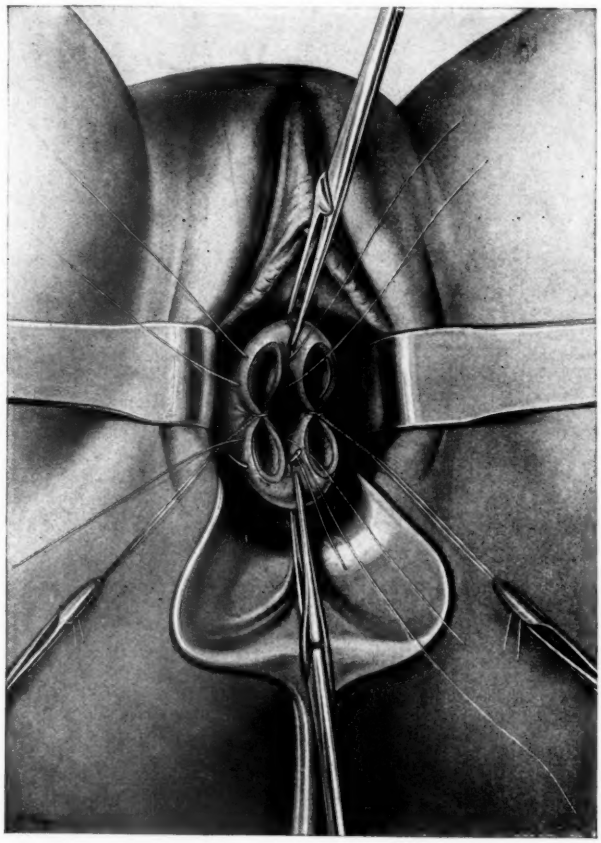

Fig. 4. Introduction of the stitches (the commissural stitches are drawn tight).

Third Stage. When the *evidement* is performed, the suturing is done. This consists in uniting the internal mucosa of the cervical canal to the external vaginal mucosa over the cervix, thus closing exactly the four small wounds; silver wire sutures are used. They are preferable to catgut, because the latter is too rapidly dissolved.

I generally use Hagedorn's small needles, but ordinary flat, curved needles, or even Reverdin's small spring needles may be used.

A silver wire is first passed at the level of the commissure or angle of section, from the vaginal to the uterine mucosa. This stitch is at once drawn tight and thus secures the immediate approximation of the commissure, and has a double advantage; it gives partial hemostasis, and facilitates the passing of the other stitches by bringing the edges of the wound in direct opposition.

A second thread should be placed on the lips of the wound near the angle, taking first the vaginal mucosa and then coming out in the mucosa of the cervical canal, near to its edge. (The extremities of each silver thread are secured by forceps, for a short time.)

A third thread is placed in the same manner, further forward. Generally two threads are sufficient to close the wound. These threads are moderately tightened by being twisted one over the other, either with the hand or with

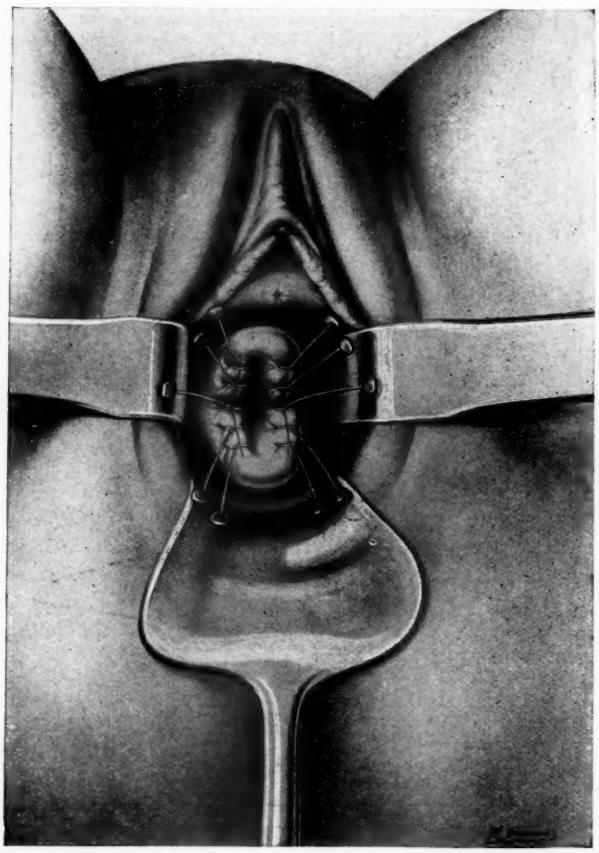

Fig. 5. The operation finished. All the stitches have been drawn tight and the leaden guards applied.

a *serre-fil*, as in the operation of vesico-vaginal fistula.

When the sutures are all inserted I force the twisted wires through small perforated bullets or shots, which are next crushed with forceps, and the extremities of the threads are cut close up to the lead, which stands about two or three centimeters distant from the suture.

There is a double benefit in using these securing shots; first, they are guiding marks to show where the threads are at the time of removal, and moreover, they prevent the sharp ends of the threads from wounding the vaginal walls. Plate 5 shows the manner of tightening the suture and the result produced by it.

In all, ten metallic sutures are generally used for exact closure of the four sections.

It is only on the twelfth or fifteenth day that the sutures are removed. This is easily effected, owing to the shots, which serve as guiding-marks to the silver wires; one must be careful to cut the ring of the suture and not the twisted ends of the threads.

For the first few days after the operation is completed, the cervix presents a peculiar aspect, similar to a duck's beak. The two lips are separate like two little valves. But, very rapidly, owing to the progress of cicatrization, a kind of retraction begins and the cervix is quite like it would be after confinement without laceration.

The cervical metritis if it existed is rapidly healed by the free drainage of the mucus and antiseptic douches.

RESULTS

I have obtained the most satisfactory results from this small operation, the benignity of which is absolute.

When care is taken to operate aseptically and only in cases where no lesions of the appendages exist, no accident need be feared, especially primary or secondary hemorrhage, for the accurate union of the wound allows no oozing of blood. Nor is subsequent infection possible, as it is where the cervical wound has been left open to spontaneous cicatrization.

I can say personally that I have not experienced a single complete failure. Success is universal as regards dysmenorrhea, which is immediately and definitely cured. Cervical metritis due to stenosis, including leucorrhea, rapidly disappears. As regards sterility, in more than 25 per cent of my cases pregnancy followed the operation, going to term without any accident, the labor being normal. Rigidity of the cervix is not to be feared, for there is no cicatricial tissue as occurs after some amputations of the cervix. Several of my cases are truly remarkable; women who had been married for five, ten and in one instance sixteen years, never becoming pregnant, were impregnated some months after the operation.

I feel assured that the operation I have described is a real improvement, and I take the liberty of submitting it to my American colleagues, hoping that they will try it, and that the American women, as well as the French, will profit by it.

A CASE OF HABITUAL DISLOCATION OF PATELLA[1]

With Operation for Its Relief

By F. E. BUNTS, M. D., Cleveland, Ohio

ON April 17, 1908, a case of habitual dislocation of the patella in a woman aged 38, was referred to me for operation by Dr. Season, and as I do not recollect that the subject has ever been presented before any of our local medical societies, I venture to submit the following history of the case as recorded by the patient herself, together with a description and illustrations of the operation resorted to for its relief.

"In regard to ancestry, I know of no one afflicted in any way resembling this. I have the family history back to great great grandfather on all sides and find that they were robust, large men and women, my father's mother being the only small one among them, whom, they say, I resemble.

"I was born in May of 1870. My first sickness was scarlet fever. This was in the spring at the age of three. The following fall I had diphtheria, from which they thought I would not rally, and after I got about they found I was cross-eyed. From this time on I remained rather weakly. At the age of ten I had pneumonia, and continued to have for the four following years. At the age of twelve I had measles very hard, after which I began to gain.

During the summer of 1882 our house was struck by lightning, my sister being killed at the time and thrown across my knees (I speak of this, as I always have thought that this shock had to a great extent something to do with my trouble, as since then I have received an electrical shock so severe I could not let go, and when released it left both knees out of place.) My first trouble was about a month after our house was struck. I was playing ball and at the time was jumping up and down, when, without warning my left knee threw me. I could not replace it for some time when, in some movement, it slipped back itself and I was helped into the schoolroom. That night I walked a quarter of a mile home. From this time on my left knee gave out without cause or warning. The effect was lameness and a swollen knee for two weeks. One day when thrown, I discovered it was my right knee that was hurt and also it seemed more painful. Later it got to be both knees at the same time, caused from trying to save the other. I can remember of my knee

[1] Read before the Cleveland Academy of Medicine, April 2, 1909.

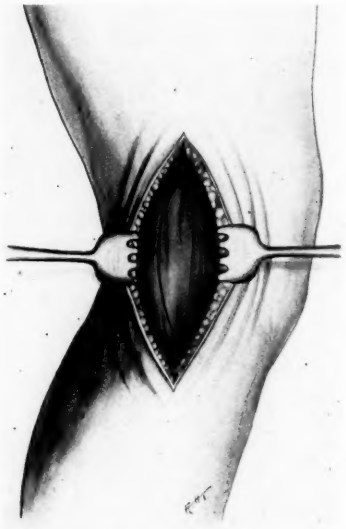

Fig. 1. Incision of skin and capsule innerside in external dislocation of left patella.

throwing me twenty to twenty-five times. The first most serious time was when returning from high school in 1889, on leaving the train I fell from the step to platform on my dislocated knee. At this time I consulted a doctor. He advised complete rest and hot water which I used for over a year without results. Local doctors advised elastic bandages and knee caps, which I have used. In the fall of 1899 I had a very serious fall, hurting the right knee badly. At this time I did not step on my leg for a month, and this was my first use of the crutch. In 1901 I fell into an excavation with my knee cap off, the right knee then being most seriously hurt. Shortly after this, perhaps six weeks, I was thrown down stairs, causing concussion, and was unconscious for an hour.

"In the summer of 1904 was the first I can remember of my knees not staying in when replaced. At this time I could not walk unless I kept my hand on my knees, and had pain the entire length of my legs. At this time my right knee was put in a cast. August of 1905 I was thrown again and tore this all loose once more. In 1906 fell at Thanksgiving, and in 1907 fell again at the same time of year and was in bed two weeks. This was the last time, you operating on April 17, 1908. Casts off May 14th; bandages off May 20th; put weight on left knee May 28th; walked with crutches May 30th; walked without crutches in house July 1st; discontinued using crutches altogether on August 1st. June 24th the right knee slipped badly and again August 13th. After giving up crutches am walking better than in years, standing erect and walking without fear. November was in Cleveland, without crutches. In November, 1908, I was leaving a residence, when stepping down a very little step my knee gave out without the least warning. I was up in an instant, and was taken home and put to bed for a short time. Now I have nothing on the knee and it seems to catch and bother in sitting down or in bending over. It burns and smarts a great deal. My left knee has not bothered me at all, while it was the one that bothered all the time while in the casts.

"In later years it was invariably the menstrual periods when the knee gave out, while the first trouble came four years before this time. Only one thing I know that would cause my knee to give out, was standing very straight or a quick straightening of the leg."

In addition to the statement of the patient, I may say that the patellæ would sometimes become dislocated when lying down with the limbs fully extended. This happened during slight muscular contraction while under the anæsthetic.

The case was an extremely aggravated one and rendered the patient practically helpless without crutches and only able to follow such occupations as might be performed in the sitting posture.

A majority of cases of habitual dislocation are commonly spoken of as congenital, and it is probable that these cases should be operated very early, perhaps at the sixth or seventh year, but there is evidently another class, such as the one here presented, in which the dislocation was predisposed to by a generally weakened condition brought on by repeated

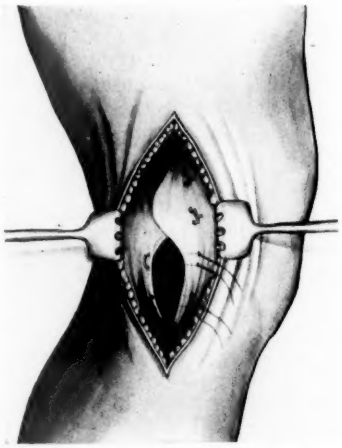

Fig. 2. Overlapping of capsule.

illness during early childhood. That the various causes commonly given, knock-knee, elongated patellar tendon, lax capsule, imperfect development of condyles of femur, undoubtedly have their distinct influence on the perpetuation of this trouble seems self-evident, but it seems reasonable to suppose that most if not all of these conditions are due to a general defect in the child's development, and not primarily to a congenital defect.

The frequency of the dislocation, the associated pain and incapacity for getting about and earning a living, constitute a very serious detriment to the patient's enjoyment of life, and numerous methods, mechanical and operative, have been suggested for relief or cure.

In the severe cases, however, mechanical contrivances will prove either inefficient or intolerable, and resort must be had to operative measures. Among the latter have been suggested osteotomy for knock-knee, transplantation of the tibial spine with its attached patellar tendon, shortening and transplantation of the tendon itself, and narrowing the capsule. Each of these operations possibly has its individual application, thus in aggravated knock-knee with the quadriceps pulling at such a disadvantageous angle, an osteotomy for correction of the deformity would naturally suggest itself, but when the condition is essentially one of relaxation either congenital or acquired, the natural operation would seem to be some method of narrowing the capsule with possible shortening or transplantation of the tendon.

The method usually suggested in this connection is to cut out an oval piece from the inner side of the capsule (the dislocation being outward) and suturing it so as to draw the patella inward.

The operation performed on this patient consisted of:

1. A linear incision 6 inches long on the inner side of the knee, through the skin and subcutaneous tissue down to the capsule of the joint.

2. A curved incision through the capsule.

3. Overlapping of cut edges of capsule by pulling inferior margin under superior margin by mattress sutures while the patella was shoved forcibly inward.

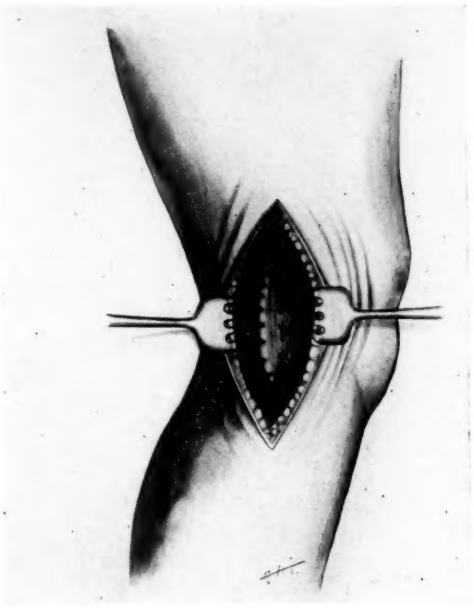

Fig. 3. Reinforcing sutures of capsule.

4. Suturing of free edges of capsule to lower portion of capsules.

5. Closure of wound without drainage.

6. Sterile dressings and plaster bandage, which were allowed to remain on for four weeks.

Both knees were operated at the same time and repair without infection followed in both.

In general the method was the same as that in the Mayo operation for umbilical hernia.

The final results have been only partly satisfactory. The patient is able to walk without crutches. The left knee has remained cured up to this time, but she has had several attacks of pain in her right knee. I have not seen her in one of these, but Dr. Season informs me that the patella was not thrown out of place but that the symptoms were rather those of a floating cartilage, a condition that is sometimes associated with repeated attacks of dislocation.

KRAUROSIS, WITH REPORT OF A CASE[1]

By JACOB FRANK, M. D., Chicago

THIS rare disease was first described by Dr. Robert F. Weir (1) of New York, in 1875, under the name "Ichthyosis of the Vulva." He then cited one case of a woman of sixty-one years, who had been troubled since the age of sixteen. Since then, fifty-one cases have been reported, but not all have been published.

The name Kraurosis comes from the Greek and means, "shrinkage of the vulva." Other terms used to designate this disease are: "Ichthyosis of vulva" (1). "Serpiginous vascular degeneration of nymphæ" (2). "Progressive cutaneous atrophy of the vulva" (3). "Hautatrophie am pudendum muliebro" (German). "Progressive præsenile und senile atrophie der Vulva mit Pachydermie" (Sanger).

The term Kraurosis was first used by Briesky (4) of Prague, who in 1885 reported the pathology of twelve cases. Later in the same year, Lawson Tait described the same disease. In 1894 (5) the most authoritative expression on the subject was given when the general opinion was that the disease was entitled to recognition as a distinct entity.

This disease is confined to the skin and connective tissue covering a part or all of the pudendum, including the fourchette and perineum. The disease does not extend to the mucosa of the vagina. It is primarily hypertrophic, but ultimately is atrophic and persists until the affected areas undergo extreme changes.

The etiology is obscure.

1. It is most common at or about the menopause, but may occur earlier or later. Cases from sixteen to seventy-two years are reported.

2. As to race being a factor I cannot state, but so far I have been unable to find any reported cases among negroes.

3. Heredity seems to bear no part in the etiology.

4. Some authors think that gonorrhea, and chronic non-specific vaginal discharges may be a probable cause; yet there is nothing definite to establish this fact. Such discharges were absent in the case reported below.

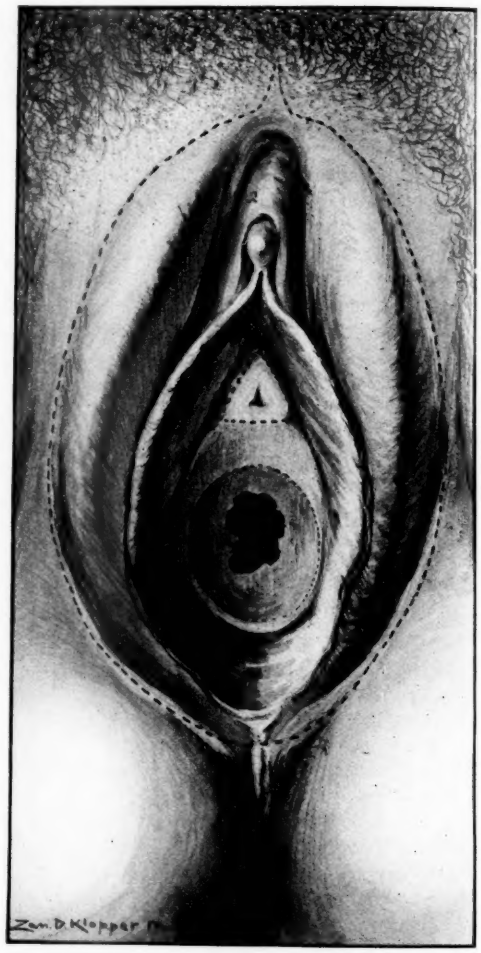

Fig. 1.

5. It occurs without the previous existence of any disease of the skin or vulva.

6. Syphilis is not a causative factor as was established by Lewin (5) who, in 1894, stated

[1] Read before the Chicago Surgical Society, April, 1909.

that he had treated between 70,000 and 80,000 women and had not found a case of kraurosis.

7. Pruritus due to diabetes is not a cause, as there has never been a case reported which had any sugar present in the urine.

8. Some cases are reported following the removal of uterine appendages, but most of the cases reported have not had any such operation.

9. I cannot state whether sterility has any bearing on the disease or not. Women have borne children before the disease, but I have no account of pregnancies following the cure of the disease.

10. It is essentially inflammatory, but is locally confined.

11. The fact that it occurs without any demonstrable local cause forces us to consider it to be of nervous origin, either from the peripheral trophic nerve filaments or their ganglia.

The pathology according to Reed and Longyear (6) is as follows:

A degenerative process occurs in the cellular tissue underlying the cuticle, preceding and leading up to the surface manifestations. Small vascular areas appear around the introitus vaginæ. These are depressed and are very painful to the touch. There is a narrowing of the vaginal orifice associated with diminished elasticity of the structures and a leather-like appearance of the tissues. There is a shrinkage of the nymphæ, mons veneris, and clitoris. Pigmentation disappears and the pubic hair becomes dry and scanty.

Microscopically there is at first a hyperemia of the tissues followed by small ecchymosis. The epithelium is irregularly thickened in spots, and in other places is very thin and almost absent. Small epithelial pearls similar to those of an epithelioma, but smaller and not so perfect, are found.

The corium presents, in the early stages, a cellular infiltration, small round cells invading the subepithelial tissue. In the later stages the cellular infiltration is less marked and there is a disappearance of the papillæ.

Bacteriologic examination gives negative results, except for such bacteria as are normally found in the vagina and on the vulva.

The symptoms vary in different cases. The first complaint is often with reference to dyspareunia. In the absence of sexual relations the disease of itself is not very painful in some cases.

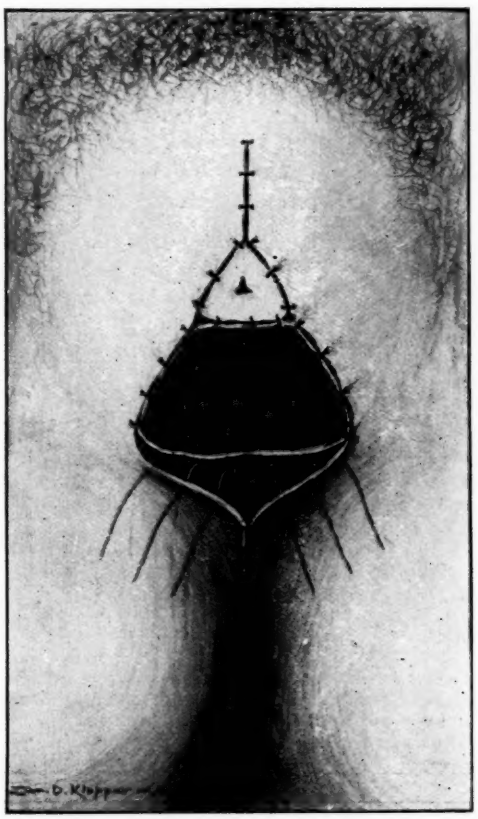

Fig. 2.

Late in the disease there is a loss of sensation in the entire diseased area, but there is never a return of elasticity to the parts.

Itching is a very inconstant factor, being a complaint in about one-half the cases. It was very marked in the case reported below.

It is to be differentiated from vaginismus in the early stage by the presence of sensitive areas and by the shrinkage. During the itching stage, if such be present, it is to be differentiated from neuro-fibrosis vulvæ which is hypertrophic instead of atrophic.

In the late stage it must be differentiated from ichthyosis, which fissures and exfoliates while kraurosis does not.

The treatment is divided into palliative and curative. The palliative consists of medications to relieve the pain and itching, such as ointments and lotions. These give but temporary, if any, relief. The curative treatment is to excise the entire diseased area.

Operation early in the disease is sometimes followed by recurrence. Operations late in the disease are not followed by recurrence.

Post-operative treatment consists of giving of tonics.

From fifty-two reported cases, since 1875, we conclude with Reed that kraurosis is:

1. A distinct disease.
2. Rare.
3. Essentially inflammatory.
4. Limited to the vulva.
5. Not syphilitic.
6. Its etiology is obscure, probably trophic.
7. Affected areas can be successfully excised.

REPORT OF CASE [1]

History. Mrs. — Married five months. White, age 28 years. A housewife, born in Canada, and lived there sixteen years. Since then has lived in Chicago.

Family history. Mother died from complications following pneumonia. Grandmother died of cancer. One aunt had a tumor removed from breast twelve years ago and is still living, with no return of tumor. A sister had a tumor removed a few months ago, and no sign of return at present date.

Other family history negative.

Personal history. Diseases of childhood. 1. When a child she had a severe attack of tonsilitis, and about the same time had inflammatory rheumatism, which kept her in bed for quite a while. She had the tonsils removed, and since then has not had rheumatism.

2. At the age of eighteen the patient had bladder trouble, and had a stone crushed. Since then she has had no bladder trouble. At the same time that she had the stone in the bladder she had a fever, which she says was typhoid, and from which she recoverd with no sequellæ.

3. At the age of eighteen or nineteen she had, what she called, "neuralgia of the brain." At that time she was very sick, being unconscious or semi-conscious for a week or more. At various times since then she has had attacks of neuralgia, but nothing severe.

Habits, regular. Appetite, fair. Drinks one cup coffee for breakfast; no alcoholics. Bowels regular, as a rule. Bladder symptoms, none.

Menstrual history. Menses began at fourteen years. Twenty-eight day type; duration about a week. Periods somewhat irregular, often being five weeks between periods. Pain during the flow. Moderate discharge. Last period, on October 12, 1907. No pregnancies.

Present complaint. About five or six years ago the patient began having, at intervals of a month or more, shooting, needle-like pains about the vulva and external genitalia. Since then the patient has had times when her general health was good, and at those times she did not have any pain nor itching; but as soon as her health became impaired the complaint returned. Later the pain and itching have become worse and more frequent. When the pains and itching came on, very small pinhead-sized white sores would appear on the genitalia, but these contained no pus. The external genitalia would swell and become dry, and the skin would scale off, after which the patient felt better. All kinds of ointment were used but no relief was obtained. The patient says that if bowels became constipated, the irritation became more aggravated. The irritation made the patient wish to relieve herself by scratching, but she refused, as it made matters worse. Since her marriage in June the trouble has rapidly increased. She has not held intercourse with her husband as it was impossible on account of pain. The patient came to me, seeking relief from itching, pain and inflammation of the genitalia and inability to hold intercourse.

Hospital history. Patient entered the hospital October 21, 1907. Physical examination showed the heart, chest and abdomen to be normal. Examination of the genitalia was impossible without an anæsthetic, as they were extremely painful to the touch.

At 8:00 A. M., October 22, 1907, the patient was put on the operating table, under anæsthesia. The pubic hair was scanty and dry. The skin of the labia minora and for two-thirds of an inch on the labia majora was dry, white, shrunken and like leather. The line of demarkation between pathologic and normal skin was abrupt. The clitoris was hooded and bound down by adhesions. The vaginal orifice was so small, due to cicatricial-like tissue, that it was difficult to insert the little finger without lacerating the parts. The hymen was intact. After the finger had passed the hymen, a normal vagina was found. Bimanual examination revealed the pelvic organs to be normal.

Operation. The patient was placed in the lithotomy position and the parts to be removed were first outlined with a scalpel by making a slight incision. The incision was started slightly above the upper border of the clitoris, in the healthy tissue, continuing around the right side of the outer border of the labia majora, passing around the posterior or commissure and thence upward along the outer border of the left labia majora to the starting point. A triangular incision was made around the mucous membrane of the urethral orifice. A posterior incision was made through the hymen, extending down to the vaginal wall. The posterior vaginal wall was dissected up and the external perineal muscles were partly cut through for the purpose of making a large vaginal opening. The labia majora, labia minora, glans clitoris and hymen were dissected away with the underlying fibrous band, as all were diseased, leaving the healthy mucous membrane around

[1] I am indebted to Dr. Nelson K. Hopkins for the hospital record and the literature of this case.

the urethra. The mucous membrane of the vaginal wall was loosened around the entire circumference to allow approximation with the healthy skin and urethra. Commencing at the upper border the skin was united from side to side until the angle of the urethral triangle was reached, when the upper portion of the mucous membrane of the triangle was sutured to the skin and the lower portion was sutured to the vagina. The remainder of the vaginal mucous membrane was sutured to the skin around the entire circumference. (See drawings.)

Patient was put to bed, and made an uneventful recovery, leaving the hospital November 9, 1907. The day of leaving the hospital a large bivalve speculum was easily inserted into the vagina without causing pain.

Since leaving the hospital the patient has had no return of symptoms, and is well satisfied with her condition.

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PRIMARY OVARIAN PREGNANCY AND THE REPORT OF A CASE COMBINED WITH INTRAUTERINE PREGNANCY[1]

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WITH the possible exception of abdominal pregnancy, primary ovarian gestation is the rarest of all forms of pregnancy. Many cases have been reported as ovarian which were probably tubo-ovarian. In 1878, Speigelberg (Arch. f. Gyn., 1878, xiii, 73) formulated certain conditions which must be fulfilled in order to justify a diagnosis of ovarian pregnancy. He demanded that (1) the tube on the affected side must be intact; (2) the fœtal sac must occupy the position of the ovary; (3) it must be connected to the uterus by the utero-ovarian ligament; and (4) definite ovarian tissue should be found in the sac wall. Williams (Text-book of Obstetrics, p. 537) has very properly claimed that the last criterion should be further modified and it must be shown that ovarian tissue is present in several portions of the sac wall at some distance from one another before the evidence becomes conclusive. This requirement is necessary, for the reason that in certain cases of tubal or broad ligament pregnancy, the ovary may be found flattened out against the gestation sac and to a certain extent forming a portion of its wall. In addition to these requirements, the tube on the affected side should not only be intact, but should be microscopically free from any evidence of gestation. Tubo-ovarian pregnancy is not a very rare condition and it can be readily imagined how, in certain cases, as the gestation sac grows, the fimbria of the tube might be torn loose and at a subsequent operation, the tube be found macroscopically normal. Indeed, we have such a specimen as this in the Laboratory of Gynecological Pathology at the University of Pennsylvania. The gestation sac in this case is the size of an orange and made up of ovarian tissue. The tube, except for adhesions and slight elongation, is macroscopically normal. The abdominal ostium is open. This case fulfilled all of Speigelberg's and William's demands and yet on serial section of the tube, fœtal tissue and other evidence leading to the conclusion that the case was originally one of tubo-ovarian pregnancy were found. This case is one of ovarian pregnancy. It is only referred to here to show the necessity of having a careful histological examination of the tube before making a diagnosis of primary ovarian pregnancy.

Primary ovarian pregnancy results from the fertilization of the ovum in the Graafian follicle. Leopold (Arch. f. Gyn., 1882, xix, 210) has suggested that in a certain proportion

[1] Read before the Philadelphia Obstetrical Society, April 1, 1909.

of cases, a centrally located follicle may rupture into a more superficial one, the ovum in the former, not being expelled, but being fertilized in its original location by a spermatozoon which gains access through the superficial follicle. Hewetson and Lloyd believe that after fertilization, the phagocytic ovum may burrow into another or deeper portion of the ovary. In the majority of cases, however, it would appear that the spermatozoon finds its way into a recently ruptured Graafian follicle and fertilizes the ovum in situ. It is interesting here, to consider the theory advanced by Webster, that the presence of Mullerian tissue is an essential factor for the development of the fertilized ovum. The uterus and the Fallopian tubes both develop from this tissue, but the ovary arises from the Wolffian body. Therefore, according to Webster's theory, there must have been an embryonal inclusion of Mullerian tissue in an ovary which is destined ever to be the seat of a pregnancy. Webster bases his theory largely on the fact that he found areas of decidual like tissue in a pregnant ovary. This theory seems rather far fetched. Areas of decidual like tissue have been found on the posterior surface of the uterus, in the peritoneum of Douglas's cul-de-sac, and on the rectum in women dying at or shortly after childbirth (Schmorl, Monat. f. Geb. u. Gyn. v. xlvi, 1897, and Kinoshita, ibid., viii, 500, 1898). Similar areas have been described occurring in the omentum and other structures distant from the uterus. Furthermore, in a careful analysis of all the cases of primary ovarian pregnancy which have been reported prior to 1909, but few are found that record the presence of decidual like cells, and in these, the identification of the latter is somewhat doubtful.

The symptoms of ovarian pregnancy differ very slightly from those of the more common forms of ectopic gestation. Usually, there is a history of a missed menstrual period followed by more or less irregular uterine bleeding which is often accompanied by cramp like pain. In Van Tussenbrock's case a decidua was passed per vagina and a history pointing to a similar occurrence is present in the majority of the recorded cases. Pain is not, as a rule, very severe unless rupture has taken place. Of the nineteen undoubted cases of ovarian pregnancy of which a brief synopsis of each case will be found below, rupture had taken place in eight cases. It should, however, be remembered that many probable, although doubtful cases of primary ovarian pregnancy have been excluded from this list. It is much easier to make a positive diagnosis of primary ovarian pregnancy prior to the sixth or eighth week than it is later, after the gestation sac has grown to such proportions as to change its relation to the surrounding parts. And as the latter cases are the ones in which rupture is most likely to occur, the figures given as to the proportion of actual ruptures is probably much too small. When rupture occurs, the symptoms are usually similar to those of the ordinary ruptured tubal pregnancy; viz., sudden sharp pain in the ovarian region followed by symptoms of shock and collapse. In two of the eight ruptured cases there was no history whatever of sharp pain. One of these was two or three months, and the other five months advanced. The bleeding from such cases, owing to the rich blood supply of the ovary is, as a rule, very free. Indeed in Croft's case (Trans. Obst. Soc. London, vol. xlii, p. 316, 1900) his patient lost her life as a result of hæmorrhage (this was a case of probable ovarian pregnancy which is not admitted to the list of positive cases on account of the lack of conclusive evidence). In every case where an operation has been performed soon after the rupture has taken place, a comparatively large amount of free blood has been found in the peritoneal cavity. The question of bleeding without rupture is an interesting one. It is a well established fact that more or less active hæmorrhage may occur from a tubal pregnancy as a result of perforation of the gestation sac by fœtal elements (syncytial cells). In a case of primary ovarian pregnancy reported by C. B. Mitchel and the author, about a year ago, the gestation sac was found unruptured, and considerable free blood was present in the peritoneal cavity. In a histological examination of this gestation sac, numerous syncytial cells were found penetrating it, many of them to its outer confines. A similar clinical condition was present in Freund's and Thome's case. In both the cases which the author has

had the opportunity of observing, the gestation sacs have been thin and soft and it would have seemed that the penetration by syncytial cells would have been an easy matter. An interesting feature which comes to light upon the study of the doubtful cases of ovarian pregnancy is that nearly half of these have reached full term. This would seem to show that the ovary can accommodate itself more readily to the enlargement of pregnancy than can the tube. The number of previous intrauterine pregnancies seem to bear no relation to ovarian pregnancy. Some of the women have been nulliparas, while others have had as many as five intrauterine pregnancies. As has already been stated, the majority of the authentic cases of primary ovarian pregnancy have been of less than six weeks' development, while among the doubtful cases are many which are at or nearly at term. There is no doubt that the list of positively authentic cases does not by any means represent the true proportion of ovarian pregnancies which occur. The reason for this is that as the gestation develops the ovarian tissue becomes so drawn out that it loses its histological characteristics and cannot in many cases be positively identified, or in case of rupture, if the patient does not at once lose her life as a result of hæmorrhage or infection, the ovarian gestation sac becomes so degenerated and the anatomical relationship between the tube, ovary, and uterus are so disturbed that a positive diagnosis cannot be made. Many lithopedions are ovarian in origin. In ovarian, as in tubal pregnancy, the uterus is usually slightly enlarged and a uterine decidua is often, if not always formed. This is usually expelled shortly after the death of the fœtus.

Ruptured ovarian pregnancy. The normal Fallopian tube and mesosalpinx are shown. The gestation sac is made up of ovarian tissue in which a number of active follicles and small retention cysts can be seen. The placenta is presenting from the ruptured portion of the sac. The lower part of the umbilical cord and the partially macerated fœtus are also shown. (As a result of the fixing solution, the sac has shrunken considerably.) This accounts for the relative disproportion between the fœtus and sac.

HISTORY OF A CASE

This patient was sent to the University Hospital by Dr. J. K. Light of Philadelphia and was admitted to the Gynecological wards, February 5, 1909. The patient is twenty-three years old and has never before been pregnant.

The menstrual history is normal. Outset at thirteen years. Regular every twenty-eight days. Duration, five days. Profuse, usually some slight backache and pain in lower abdomen for first day.

The family history is negative.

The general previous history is good. The heart, lungs, and kidneys are normal.

Development of present condition. The patient's menstrual flow was always regular and normal until last April. At this time her period was only a "show," lasting two days and barely staining the napkins. Her menstrual periods continued in this way until August, at which time she bled quite profusely for three days. The flow then became very scant but lasted somewhat irregularly, sometimes profuse and at other times ceasing for a few days until October. Previously to this flow, the periods had come on at the regular time. There has been no bleeding since October. The patient has not been sick and has had no fever. At no time has pain been a pronounced symptom.

Examination on admittance. The breasts are slightly enlarged and contain colostrum. The pelvic examination shows a faint bluish discoloration of the vagina. The cervix is softened and in normal position. Hager's sign is present. Bimanual examination shows the body of the uterus uniformly enlarged and rising slightly above the symphysis. It is markedly deviated to the right. The left and central portion of the abdo-

men is occupied by a mass which rises to within three fingers' breadth of the umbilicus. This mass is very irregular. On the left it is hard and separated from the uterus by a distinct groove. Just above the symphysis is a hard mass which feels like a fœtal shoulder. Abdominal palpation elicits no pain.

Operation February 8, 1909, *by Dr. John G. Clark.* A median incision was made and the peritoneal cavity packed off with two large rolls of gauze. The right ovary and tube were now inspected and found normal. A large corpus luteum was present in the latter. The left ovary had been converted into a gestation sac the size of an orange. This was ruptured on its inferior and outer aspect. A fœtus, somewhat macerated, of about five months' development was present. This was partially within the gestation sac. The left tube and broad ligament and the tubo-ovarian ligament were clamped with hæmastatic forceps and cut away. The tube, gestation sac, and fœtus were then delivered from the abdomen together. The uterus was now brought up with a grasping forceps and opened. The intrauterine fœtus was now delivered without rupture of its membranes The placenta was separated from the uterine wall with the fingers, and a gauze pack introduced into the uterus through the incision. The incision in the uterus was then closed by the method of Sanger. The operation was continued by completing the salpingo-oopherectomy. The appendix was now removed and the abdomen closed. At the consummation of the operation, the patient was returned to the ward in good condition. The intrauterine pack was removed on the day following the operation. The patient's convalescence was entirely normal.

The interesting points of this history are that the rupture of the ovarian gestation sac produced no severe symptoms and that the irritation from the presence of the fœtus in the peritoneal cavity was not sufficient to prevent or interfere with the subsequent intrauterine pregnancy. Schickele's case was similar to ours in that there was no history of severe pain, although in his case a two or three months' ovarian pregnancy ruptured and was followed by profuse bleeding.

PATHOLOGICAL REPORT

(From the Laboratory of Gynecological Pathology, University of Pennsylvania.)
Path. No. 2076.

Macroscopic description. The specimen consists of an intrauterine gestation sac, the left tube, a left ovarian gestation sac and its contents, and the vermiform appendix.

The intrauterine gestation sac. Has been removed without rupture. It is a rounded flaccid sac, of about the size of a goose egg, the greatest diameter of which is 8.5 cm. The umbilical cord shows many twists. The fingers and toes of the fœtus can be distinguished. The sex cannot be positively recognized

Left Fallopian tube. Is 11 cm. in length. Th diameter through the uterine extremity is 5 m.m. through the isthmus, is 6.5 m.m.; and through th ampulla, 7.25 m.m. The abdominal ostium is open The fimbria are luxuriant and entirely normal. Th peritoneal surface shows two light adhesions near th middle of the tube. With the exception of the abov mentioned adhesions, the tube is grossly normal. I appears patulous, but as it will be necessary to cut sec tions at short intervals through its entire length, it i best not to pass a probe as this point can be definitel settled by the microscopic examination. The meso salpinx is entirely normal.

Ovarian gestation sac. Beneath the tube is a rounded, somewhat spherical mass, measuring 15 x 12.5 x 12 cm. This is covered by a thick, whitish glistening membrane which resembles the tunica albuginea of the normal ovary. Here and there on the surface, small cysts are present. These are most numerous in the superior aspect of the sac, but also appear on its lateral surfaces. They vary from a few m.m. to 1.6 cm. in diameter. Some contain clear, slightly yellowish fluid, others dark coagulated blood. These macroscopically resemble active follicles and small retention cysts, such as are seen in the ovary. The wall of the sac varies from 1 m.m. in thickness in its lower portion, to 3 or 4 m.m. in its upper. This sac has been but little mutilated at operation. About three-fourths of the entire sac appears to be present. This is in its original shape. The sac contains the placenta and membranes. The inner surface of the sac is smooth, some points show areas of ecchymosis, while other parts are partially covered by layers of laminated blood clots.

Ovarian placenta. This is a rounded mass occupying the upper and inner portion of the above mentioned sac. It is yellowish gray in color and is evidently undergoing degenerative changes. The umbilical cord, somewhat twisted and degenerated, is attached to the placenta. It is 10 cm. in length. A small portion of tissue about 1.25 cm. in diameter, is present, attached to the distal end of the cord. This tissue is apparently part of the anterior abdominal wall.

Ovarian fœtus. The legs are flexed on the thighs and the thighs on the abdomen. The fœtus would measure about 20 cm. in length if extended. The thigh, knee, ankle, elbow, and wrist joints are ankylosed. The head is somewhat crushed and the bones fractured. Its greatest diameter is 6.85 cm. Before flattening, it probably measured about 6.75 x 6.5 x 6 cm. Some places on the body show areas of adipocere like change, while in others a lithopædion transformation is taking place. The latter is especially noticeable in the lower extremities. The sex is male. This case is apparently one of ovarian pregnancy in which rupture has occurred and at which time death of the fœtus has taken place. This fœtus is of about five months' development.

Vermiform appendix. Is 8.5 cm. in length. The surface shows a few adhesions which are more numerous

towards the tip. The diameter is uniform, but is somewhat greater than normal, averaging about 7.5 m.m. The organ appears to be the seat of a peri-appendicitis.

HISTOLOGICAL DESCRIPTION

Section from the uterine placenta. This shows the usual characteristics of a normal healthy placenta at about the third month of development.

Left Fallopian tube. Sections have been taken at .5 cm. intervals throughout the entire length of the tube, including the fimbria of the abdominal ostium. None of these show any pathological change. The sections from the proximal third of the tube contain a well formed decidua. At this point, the mucous folds are swollen and blunt. The surface epithelium consists of a single layer of cuboidal cells which have nuclei somewhat less tingeable than normal. The stroma is composed of round, oval, or polyhedral cells some of which are five or six times as large as the normal stroma cell. The outline of these cells can be distinguished but is not sharply defined. The protoplasm is finely granular. The nuclei are but slightly enlarged, but are less tingeable than the normal. The blood-vessels are engorged. Many of them contain well developed muscular walls. The lumen is empty. A section through the uterine cornua (intramural portion of the tube) shows none of the characteristics of pregnancy. It is normal. The sections from the outer two-thirds of the tube are also entirely normal.

Ovarian gestation sac. Of the ten sections which have been taken from various points in the sac wall, six show positive evidence of ovarian tissue. One of the sections shows a well developed Graafian follicle. Another shows a small Graafian follicle cyst. Another, a healing corpus luteum. Another section, which comes from the inferior aspect of the tumor contains a Graafian follicle, while in still another, a portion of a large degenerated corpus luteum is present. The ovarian tissue is as a rule, somewhat drawn out and shows the result of pressure. In some areas, a slight chronic inflammatory reaction is present. The placenta is represented by chronic villi. These are seen as rounded or oval bodies, some of which are enclosed in blood clots. Nearly all the villi have lost their syncytial investment. The villi are for the most part, pale, granular, translucent bodies in which some stroma tissue can still be recognized. Although it is impossible to state definitely, on account of the degenerative changes which are present, it would appear that the choronic villi had rested in a layer of blood between which and the ovarian tissue was a well developed fibrin layer. A few syncytial cells can be recognized in the ovarian stroma. No villi are present in the ovarian stroma. At one point, the remains of a large flattened and degenerated corpus luteum is seen. No decidual like cells are present nor is there any positive evidence of a theca interna or externa, although this is probably a follicle pregnancy.

Vermiform appendix. With the exception of a few surface adhesions towards the tip, the organ is normal.

Pathological diagnosis. Normal intrauterine pregnancy of about the third month of development. Normal left Fallopian tube containing the decidua of the intrauterine pregnancy. Left ovarian pregnancy of about the fifth month of development. Rupture of the ovarian gestation sac and partial lithopedion and adipocere transformation of the fœtus. Periappendicitis.

This case conforms to all of Speigelberg's and Williams' demands. Both tubes were macroscopically normal. The gestation sac occupied the position of the ovary. It was connected to the uterus by the ovarian ligament and the sac itself, contained definite ovarian tissue which was demonstrated in various sections, which were taken from the sac wall at some distance from one another. The case could not be a tubal or a tubo-ovarian pregnancy as sections taken at intervals of .5 cm. from one another throughout the entire length of the tube, including the fimbria at the abdominal ostium, failed to show any evidence of extrauterine pregnancy, the tube being entirely normal except for a few light adhesions over its middle third, which were probably produced at the time of rupture of the ovarian gestation sac. The inner third contained a decidua, the result of the intrauterine pregnancy. The case could not have been one of abdominal or broad ligament pregnancy, as the entire placenta and a part of the fœtus was found enclosed in the ovarian gestation sac.

In 1876, Parry (Extra Uterine Pregnancy, London, 1876,) suggested the term "combined pregnancy" as indicating the condition of intrauterine and extrauterine pregnancies occurring synchronously in the same individual. Since this time much work has been done on the subject of extrauterine pregnancy and numerous cases of combined pregnancies have been reported. In 1898, Straus (Zeit. f. Geb. u. Gyn., xliv, p. 26, 1900) collected thirty cases of combined pregnancies, not including the twenty-two cases previously reported by Parry, while Zincke (Am. Jr. Obst., 1902, xlv, p. 623) in 1902 collected eighty-eight cases. Our case is, however, we believe, the second case of combined intrauterine and ovarian pregnancy to be recorded, and is the first case in which the gestations have been at different stages of development. The fact that our patient should become pregnant while carrying a good-sized ovarian tumor containing a lithopedion of 20 cm. in length which apart from

producing irritation, deviated the uterus quite markedly from the median line, is remarkable. Lithopedion formation is, at least in some cases, peculiarly unirritating, as proven by Kuchenmeister (Arch. f. Gyn. 1881, xvii, 153). Numerous cases are on record where lithopedions have been carried in the abdomen for years without producing serious symptoms. Of the nineteen authentic cases of primary ovarian pregnancy on record, ten have shown a distinct corpus luteum formation, while in five others it was doubtful, but probably present. This bears out the theory already advanced, that the spermatozoon enters a recently ruptured Graafian follicle and there fertilizes the ovum. Of these nineteen cases, eleven are pretty well proven to have been follicle pregnancies by the histological studies. Hewetson and Lloyd suggest that in those cases in which no lutein cells are found, they may have been absorbed or destroyed by the action of the trophoblast. The method of union between the maternal and fœtal structures is of interest. In both our cases the villi rested in a layer of blood and were limited by layers of fibrin, never as far as we were able to demonstrate, actually reaching the ovarian stroma. Between the maternal tissue and the ovum were intervillous spaces filled with blood. A similar condition is described in Freund's and Thome's case and by others.

In a fairly extensive search through the literature of ovarian pregnancies covering the last ten years, with especial care, the author has found nineteen positive cases. In compiling this list great difficulty was met with. Many cases which were in all probability true primary ovarian pregnancies were excluded from it because of a meagerness of the report, a lack of microscopical confirmation of the clinical diagnosis, failure to make a histological report on the condition of the Fallopian tube and other details which are necessary before a positive diagnosis of primary ovarian pregnancy can be made. The following is a short synopsis of the positive cases followed by a table embracing the chief points of interest of each.

G. P. Anning and H. Littlewood (Trans. Obst. Soc. London, vol. xliii, p. 14, 1901). The patient was twenty-eight years old. She was operated on August 27, 1900, for a ruptured ectopic gestation, about thirty-six hours after the rupture. About two pints of blood clots were removed; a small ovum was found. This fitted into a firm envelope composed of laminated clots. There was a rent in the right ovary leading to a cavity which contained some blood; into this the ovum and sac exactly fitted, clearly indicating the primary ovarian origin of the pregnancy. The right tube was removed. The patient made a good recovery. The specimens were exhibited with microscopic specimens of the ovum, the sac, and a portion of the ovarian wall.

J. C. Webster (Trans. Am. Gyn. Soc., vol. xxix, p. 65, 1904). The patient was thirty-six. Married ten years. II para. One period missed. On September 7, was seized with severe pain in lower abdomen and felt faint. On the following day blood and shreds of tissue were passed per vagina accompanied by colicky pains. At operation, about a half an ounce of dark fluid was found in the uterovesical pouch. The swelling on the right side of the uterus was attached to adjacent structures by delicate adhesions. Macroscopically, the ovarian tumor was an irregularly rounded swelling measuring 8 x 7 cm. and of a dark chocolate color. The amniotic cavity was situated nearly in the center of the mass. It measures 2.2 x 1.5 cm. The tube was normal. These findings were confirmed by the microscopic examination. A degenerating corpus luteum was present. Areas of decidual like cells were found in the ovary.

J. T. Hewetson and J. Lloyd (Brit. Med. Jr., Sep. 8, 1906, p. 568). The patient, aged thirty-five, was sent to the hospital as a case of subacute appendicitis. Married eight years. II para. The patient missed one period and was thought to be pregnant. Six weeks after her last period she was taken with severe pain in the lower abdomen, followed by symptoms of collapse. On the following day, the patient began to bleed and pass small pieces of tissue per vagina. On opening the abdomen a large amount of porter colored fluid was found in the peritoneal cavity. The uterus was larger than normal. The pregnant ovary was represented as a rounded plum colored mass. The amniotic cavity me sured 3.23 x 2 cm. Diagnosis confirmed by the microscope.

Van Tussenbrock, Catherine (Anneles de Gyn. et Obst. Dec., 1899). This is the first case in which a complete demonstration of an ovarian pregnancy has been made. The patient was thirty-one and was a V para. Last period six weeks before. The clinical history pointed to extrauterine pregnancy. A great quantity of free blood was found in the abdomen. Clots were adherent to the right ovary. From the fourth to the seventh day after operation fragments of decidual membrane escaped from the uterus. The ovary — probably originally of large size, as in Freund's and Thome's case — was quite separate from the tube. The ovisac contained a partially macerated embryo 12 m.m. long, on which head, caudal extremity, and commencement of limbs could be distinctly seen. The umbilical cord was short and thick. The ovisac was within a corpus luteum and the ovum was completely surrounded by a theca interna, composed of large granular necrotic cells much resembling decidual cells.

Between the fœtal tissues and the theca interna was a layer of connective tissue. The entire ovum was surrounded by villi, there being no destoid placenta formed. The villi showed syncytial and Langhan's cells. Fœtal and maternal tissues were united through a medium of fibrin, probably derived from the necrotic trophoplast, in which, however, the maternal tissue may also have taken part. (Quoted by Kelly and McIlroy.) This case was operated on and reported by Kouwer in 1897, (Cent. f. Gyn. 1897, 1426). It was not, however, accepted as a case of primary ovarian pregnancy until 1899 when Van Tussenbrock's carefully detailed account of the specimen appeared.

M. de Leon and Holleman (Rev. de Gyn., June, 1902). The patient was thirty. She was a III para and had had one miscarriage. Four months before there had been amenorrhea for six weeks. This was terminated by sudden abdominal pain and hæmorrhage. The tumor was formed entirely by the ovary. The tube was normal. No embryo was found, but many villi were present. No corpus luteum was found. The authors think this was a follicle pregnancy. In the wall of the fœtal sac were cells belonging to the theca interna. A group of cells was found which they think were partly trophoplastic and partly decidual.

H. W. Freund and R. Thome (Virchow's Arch., Jan., 1906). The patient was a primipara, twenty years of age. Amenorrhœa had been present for three months. The diagnosis of extrauterine pregnancy was made. At operation a considerable amount of blood stained serum was present in the peritoneal cavity. The tumor was formed entirely by the right ovary. The tube was normal. The left ovary was 8 cm. in length and situated above the pelvic brim. The embryo was 13 m.m. in length and lay in an ovisac with a cord 11 m.m. in length. The amniotic cavity lay near the center of the ovary. The gestation sac varied in thickness from 1 to 2 cm. The embryo had been dead for some time. The authors think this was a follicle pregnancy. No granulosa, lutein, or decidual cells were found. In the villi, both layers were present. The villi lay in a layer of blood. A layer of fibrin interceded between the villi and the maternal tissue. No actual placenta was present.

J. K. Kelly and A. L. McIlroy (Jr. Obst. and Gyn. Brit. Emp., vol. ix, No. 6, p. 389, 1906). The patient was thirty-three. Married twelve years. V para. Had not menstruated for 6 weeks when she was seized with severe pains in both iliac regions. The next day, she began to bleed. These symptoms continued for two weeks. She lost flesh and strength and was very weak and ill when seen by the author. A diagnosis of extrauterine pregnancy was made. At operation, a hæmorrhagic cyst the size of a large plum was found springing from the left ovary. Both tubes were normal. The left ovary was twice its normal size. The gestation sac was very thin. No embryo was found. A well developed corpus luteum was present. The entire gestation sac was composed of ovarian tissue. The pregnancy had occurred in a Graafian follicle as proven by the presence of lutein cells almost directly adjoining the fœtal epiblastic structure, but separated from it by a layer of fibrin and connective tissue. No rupture had taken place. The fact that no decidual cells were found negatives the statement that pregnancy can only take place on tissue which has undergone previous genetic influence. No tubal decidua was present.

J. T. Thompson (Trans. Am. Gyn. Soc., vol. xxvii, 1902, p. 338). The patient was thirty-two. II para. For the last seven years, more or less pelvic pain. Menstrual history regular. No amenorrhœa. Severe pain was the chief symptom which had been present for a month before being seen by the author. At operation, a dark red tumor, the size of a horse-chestnut, was seen springing from the left ovary. On macroscopic examination, this proved to be an ovarian gestation sac. No rupture had taken place. The Graafian follicle, which ruptured at the last menstrual period, was present. A few adhesions were found. The tube was normal. The fœtus was 1.2 cm. in length. Attached to it was an umbilical cord 1.5 cm. in length. The appearance of the inner surface of the ovisac was quite similar to that of the pregnant uterine body at an early period. It was estimated that the fœtus was twenty-five to thirty days old. No trace of amnion could be found. This was a follicle pregnancy.

J. C. Webster (Trans. Am. Gyn. Soc., vol. xxxii, 1907, p. 122). The patient was twenty-one. Missed one period. This was followed by irregular bleeding which finally became quite profuse. During this time she was confined to bed. The breasts were somewhat enlarged. The uterus, normal in size. On opening the abdomen, the right ovary was found to have been converted into a rounded, dark colored tumor which was adherent in Douglas's cul-de-sac. The tumor measures 8 x 7 cm. The surface was lobulated. Occupying the central portion of the ovarian swelling was an ovoid cavity 3 x 4 cm. This was lined with an amnion and contained fluid. An embryo, 2 cm. in length attached by a short cord to the wall of the cavity was present. Indications of limb buds were visible. A small area of decidual like cells was found on the surface of the sac. Only a small amount of normal ovarian tissue was present in the gestation sac wall. This was on the superior surface. The tube was normal.

Boesbeech (Monat. f. Geb. u. Gyn. Berlin, 1904. Bd. xx, p. 613). A woman forty-one years of age. Two children. History of irregular menstruation. No decidua passed. At operation, a parovarian cyst was removed. The corresponding ovary was twice its normal size and had a rupture. This case is somewhat similar to Van Tussenbrock's. Villi were found at the point of rupture, while syncytial cells were discovered in various portions of the ovisac wall.

S. D. Jacobson (Contributions to the Science of Med. and Surg. N. Y. Post Grad. Med. School and hospital, 1908, p. 241). The patient was twenty-eight. I para and one miscarriage. The patient missed one period followed four days later by an irregular flow accompanied by cramp-like pains. An oopherectomy and partial salpingectomy was performed. The ovary was represented by a rounded mass about 7 cm. in diameter. The tube was grossly normal. Near the center of the ovarian mass was a small cavity contain-

ing an embryo, 6 m.m. in length. Villi were said to have been present in the ovarian substance (presumably the author means stroma). The outer portion of the tube was normal. The histological report is very meager. No mention is made as to the presence of decidual tissue, nor is it stated if a corpus luteum was present. Furthermore, the report is lacking as to whether this is supposed to be a follicle pregnancy. The case is, however, probably an authentic one. The author claims that it is accepted by J. H. Bolt, G. M. Edebohls, and others.

Micholitsch (Zeit. f. Geb. u. Gyn., 1903. Bd. 49, 508). This author reports two cases. Case 1. A I para. Operation per vagina. Right salpingo-oopherectomy. The ovarian tumor was the size of an apple. On section, a hæmatoma, the size of a hazel was found in a smooth lined cavity. The capsule of the hæmatoma showed ovarian tissue and choronic villi. No embryo was found. Case 2. A II para. Twenty-three years of age. She missed one period and four weeks later had an irregular flow. Operation by the vaginal route; left salpingo-oopherectomy performed. The tube was normal. The tumor had been partially torn loose from its attachments during operation, but had been definitely attached to the utero-ovarian ligament. Definite ovarian tissue was found in the sac together with choronic villi. No mention is made of a fœtus.

C. C. Norris and C. B. Mitchell (Surg. Gyn. and Obst., May, 1908, p. 460). Age thirty-one. I para. The clinical history was characteristic of extrauterine pregnancy. One period was missed, followed a week later by irregular bleeding and colicky pain in the lower abdomen. At operation, considerable free blood was present in the peritoneal cavity. Macroscopically the specimen consisted of a tube and ovary. The tube was normal. The ovary measured 2.8 x 1.6 x 1.4 cm. Springing from its inferior surface was a gestation sac, the outer covering of which was continuous with the tunica albuginea of the ovary. The outer surface of the sac contained a few follicles similar to those found in the normal ovary. In the center of the ovisac was an amniotic cavity. Histologically, serial sections from the tube show this to be normal. Sections through the ovary and ovisac showed the ovary to be unusually vascular. Its center was occupied by a large corpora albicantia. Between the ovisac, and in the ovary was a large well developed corpus luteum. The choronic villi lay in a layer of blood which was separated from the stroma of the ovary by a layer of fibrin. Syncytial cells were, however, found in the stroma of the ovary. No fœtus was found. At various points in the wall of the gestation sac ovarian elements were positively recognized. At operation, the gestation sac was attached to the uterus by the ovarian ligament. This case fulfills all of Speigelberg's and Williams' demands.

J. M. M. Kerr (Proc. Roy. Soc. Med., vol. i, No. 9, 1908, p. 268). Age twenty-seven. I para. Menstruated normally, Nov. 20th. Missed the December period. Early in January had two severe attacks of pain in the lower abdomen. A diagnosis of extrauterine pregnancy was made. On January 13th the abdomen was opened and the right tube and ovary excised. About two pints of dark blood was removed from the peritoneal cavity. The uterus was slightly enlarged. The patient made a normal convalescence. On examination of the tube and ovary, the former was found to be slightly enlarged and congested. The hilum of the ovary appeared normal. The lower half was enlarged and hæmorrhagic. The ovisac was found in this portion. Rupture has occurred. A large corpus luteum was present. The amniotic cavity measured 1.35 x 1 cm. The ovum was found. A few cells, not unlike decidual cells were present, but they "do not constitute anything resembling a real decidua." This was a follicle pregnancy. Two hundred and seventy-six days after the patient's last menstrual period; viz., Aug. 19th, the patient gave birth to a healthy full term child. The author believes that the intrauterine and extrauterine pregnancies began at the same time.

Gottschalk (Cent. f. Gyn., 1886, x, 727). Age twenty-six. Nullipara. This patient's chief symptom was pain in the right side. The specimen shows the right tube normal. The place of the left ovary was taken by a soft tumor the size of an orange. The uterus was normal. The ovarian tumor contained slightly yellowish fluid, in which was an embryo 7 m.m. in length. This lay free in the yolk sac, the amnion being intact. In the wall of the gestation sac was a Graafian follicle.

R. Bandel (Beitr. z. Klin. Chir., 1902, xxxvi, 657). Age twenty-two. Died of angina ludvica. The autopsy revealed the following condition. The uterus was enlarged. A uterine decidua was present. Microscopic examination showed both tubes inflamed and occluded and oopheritis on the right side. The place of the left ovary was taken by a tense, brownish red, egg-shaped tumor. The left tube was not attached to this mass. The tumor contains chocolate brown blood and shows positive evidence of pregnancy. Primordial follicles and other evidences of ovarian tissue were found in various portions of the sac wall. A corpus luteum was present. The salpingitis must have closed the outer end of the tube after the passage of the spermatozoon.

Franz (Hager's Beitrage z. Geb. u. Gyn., 1902, vi, 70). Age twenty-one. I para. Five weeks after a normal menstrual period was attacked by severe abdominal pain and backache which confined the patient to bed. This attack lasted for one week. There was no bleeding. Two weeks later the pain recurred accompanied by bleeding which continued until the date of operation. Examination of the specimen showed the tube normal. The place of the ovary was taken by a hæmorrhagic tumor which was ruptured at two points. The pregnancy was of four or five weeks' development. Immediately around the ovum are a few small groups of decidual cells.

G. Schickele (Beitr. z. Geb. u. Gyn., 1906, xi. 317). Age twenty-eight. IV para. Amenorrhœa was present for two months terminated by an irregular flow which lasted for three days. This patient never had any sudden pain or collapse. The Fallopian tube was normal. The gestation sac was ruptured. A large

pelvic hæmatocele was present in which were found choronic villi and amniotic remains.

Foot-note. August Martin in his Diseases of The Appendages reports two cases, one of which from the illustration leaves little doubt as to its authenticity; the other is a doubtful case. There is no data to either. J. B. Perkins, in a personal communication, informs me that he has had one case, the report of which is now in the hands of the Secretary of the Am. Gyn. Soc.

Reported by	Age	Menstrual History	Ruptured	Pain	Development	Corpus Luteum	Follicle Pregnancy	Decidual-like Tissue	Previous Pregnancies	
Anning & Littlewood	28	Amenorrhœa for 1 mo. Symptoms of extra-uterine pregnancy	Yes	Severe	4–6 wks.	Yes	Probable	No	2	Operation 36 hours after rupture. About 2 pints of blood and clots present in the peritoneal cavity
Webster	36	Amenorrhœa for 1 mo., terminated by bleeding day following operation. Symptoms of extra-uterine pregnancy	No	Severe	6 wks. or less	Yes degenerating	?	Yes	2	1 oz. of blood present in utero vesical pouch at operation
Hewetson & Lloyd	35	Amenorrhœa for 6 wks. Then irregular bleeding	Yes	Severe	7 weeks or less	Yes	?	No	2	
Van Tussenbrock	31	Amenorrhœa for 6 wks. After operation irregular bleeding	Yes	Yes	6 wks. or less	Yes	Yes	?	1	First proven case of primary ovarian pregnancy
de Leon & Holleman	30	Amenorrhœa for 6 wks. Then bleeding	No	Severe	6 wks. or less	No	Yes	?		
Freund & Thomé	20	Amenorrhœa for 3 mos.	No	Yes	4 mos.	No	Yes?	No	0	Embryo had been dead for some time. No proper placenta present. Opposite ovary infantile
Kelley & McIlroy	33	Amenorrhœa for 6 wks. Then bleeding	No	Yes	6 wks.	Yes	Yes	No	5	No embryo found
Thompson	32	Regular	No	Yes	4 weeks	Yes	Yes	No	2	Distoid placenta present
Webster	21	Amenorrhœa for 7 wks. Then bleeding	Yes	Yes	6 wks. or less	?	?	Yes	?	
Boesbeech	41	Irregular	No	Yes	About 2 mo. or less	Yes	Probable	No	2	No decidua passed per vagina
Jacobson	28	Period overdue 4 days. Then irregular bleeding	No	Yes	6 weeks or less	?	?	?	1	
Micholitsch	?	?	No	?	3 months or less	?	?	?	1	No embryo found. Gestation sac degenerated
Micholitsch	23	Amenorrhœa for 2 mos. Then bleeding	No	Yes	8 wks.?	Yes?	?	?	2	
Norris & Mitchell	31	Amenorrhœa for 7 or 8 wks. Then bleeding	No	Yes	6 wks.	Yes	Yes	No	1	No fœtus found
Norris	23	Irregular for 10 mos. prior to operation	Yes	No	5 mos.	Yes	Probable	No	0	Combined with a 3 mos. intra-uterine pregnancy
Kerr	27	Amenorrhœa for 7 wks. No bleeding	Yes	Yes	less than 7 wks.	Yes	Yes	?	1	Combined with intra-uterine pregnancy. Fertilization being synchronous in both
Gottschalk	26	?	No	Yes	4 wks.	No	Probable	No	0	
Franz	21	Amenorrhœa for 5 wks. Then severe bleeding	Yes	Yes	4–5 wks.	No	?	Yes	1	
Schickele	28	Amenorrhœa for 2 mos. Then bleeding and passage of decidua?	Yes	Slight	2–3 mos.	?	?	No	4	Large pelvic hæmatocele

OBSTRUCTION OF THE BOWELS

By T. C. WITHERSPOON, M. D., Butte, Montana

I SHALL present in this paper my experiences in the treatment of this interesting condition and not attempt a rehash of the literature. The special anatomy and pathology will be referred to only in so far as they directly bear upon its treatment.

Too often, only the post-mortem, or illy advised long search upon the operating table, reveals the true state of affairs. Theoretically, a distinctly exhaustive classification of bowel obstruction is helpful in arriving at a diagnosis of the cause or position of the lesion, but, in turn, this very knowledge is an incentive to proceed at length with the operation. To the more practical and satisfactory side of the problem: "How shall we deal with the obstruction to get the patient well?" will I invite your attention.

I know of few conditions which bring to the doctor such responsibility as this and it is the one above all others, wherein an exact conception of the practical is needed to reduce a fearful mortality. Upon prompt and well directed action, must success depend. The attitude of inaction, known too often as conservatism, is fatal. I have endeavored, for some years, to devise a uniform method of treating these patients which might limit handling in the operating room and shorten the time of surgical procedures. There are a certain number of these patients who offer clear indications as to what is necessary, but a large number present to the mind of the operator doubtful indications as to what is most expedient. One can always eviscerate the abdomen and thereby fully determine the position and character of the obstruction and at the same time relieve the purely mechanical difficulty, but this entails an increased mortality. Is there not a satisfactory method short of a too radical procedure which might materially increase the number of recoveries?

I will call attention to my successes and my failures and try to point through these my present attitude in the treatment of recognized bowel obstruction.

I have grouped my cases as follows:

	Number	Deaths
Toxic, potential obstruction	7	1
Inguinal hernia, strangulated in situ	4	
Inguinal hernia, strangulated, reduced en mas.	3	
Femoral hernia, strangulated, in situ	4	1
Femoral hernia, strangulated, reduced en mas.	1	1
Umbilical hernia, strangulated	2	
Invagination in children	4	1
Invagination in adult	1	1
Cæcal cancer, invaginated	1	
Cæcal tuberculosis, acute obstruction	1	
Cancer, heptic flexure of the colon with acute obstruction	1	1
Appendix surrounding jejunum	1	
Appendix abscess with adhesions to wall of pelvis	5	1
Meckel's diverticulum, causing acute obstruction	1	0
Sigmoid ulcer with acute obstruction	1	

It will be observed I have followed no general classification in grouping these cases, but placed them under different headings determined by the "Cause of the obstruction." They are cases of which I have a record and number thirty-seven in all.

The toxic cases are those upon whom I operated and proved the absence of organic lesion; the diagnoses, in the others, were all proven upon the operating table. There were seven deaths in the thirty-seven cases, giving approximately, nineteen per cent mortality. The mortality in the individual groups is seen by reference to the table.

I have not included the cases of so-called post-operative or traumatic gastro-mesenteric ileus. These cases alone would require a paper to discuss them and their management.

In many of the cases the diagnosis of the obstructing agent was made before the operation, but in a fair number, this was impossible. The most puzzling problems were offered by the cases I have put under the heading of "Toxic" obstruction. In those of hernias reduced "en mas," the physical signs were not sufficient to make an exact diagnosis before operation, though the history pointed strongly to the probability of the true condition.

In the cases of invagination, the diagnosis was made in each instance prior to the operation. The cancerous and tuberculous cases presented a mass which directed the route of operation, though the exact pathology of the trouble was only made clear upon operating.

In obstruction from the encircling appendix and from the Meckel's diverticulum, the diagnosis was not made until the abdomen was opened in each instance, and in one case, in which the bowel was kinked and adherent to the pelvic fascia in the environs of an appendiceal abscess, the obstructing cause was not ascertained until laparotomy was done for relief of the obstruction.

Under the head of the toxic obstruction, I wish to say a few words about "Fæcal obstruction." This is perhaps a text-book expression which has had more to do with causing a high mortality rate than has any other adverse factor in connection with the subject of bowel obstruction. It has not been my fortune to be called as consultant in an obstructed bowel case in which the obstructing cause was not patent, but that I had to face the question of fæcal impaction. The inadvisability of too early or too rash surgical measures, until the entire list of cathartics and enemas have been given a trial in order to remove a supposedly obstructing mass of fæcal substance, is always insisted upon, and no amount of argument against these seems to avail, until the condition of the patient is decidedly bad.

In my list of cases, I have failed to discover one which I could look upon as a bona fide case of fæcal impaction of the cæcum or small bowels, pure and simple. In fact, I do not think I have ever seen a simple fæcal impaction, except in the rectum and lower sigmoid. This latter is an occasional condition with which we meet and in no way offers serious difficulty to diagnosis or treatment. That hardened masses in the lower bowel usually cause the symptoms of obstruction, is contradicted by the hundreds who go from several days to weeks without a bowel movement and still suffer no greater inconvenience than headaches, backaches, bloating and abdominal discomfort, and lack of appetite with coated tongues. If we could rob our text-books of this expression, I am convinced we could reduce the mortality in these cases at least ten per cent or more. It would help to do away with procrastination and harmful efforts at purging.

The one death I had from toxic obstruction was unquestionably due to operative measures carried too far. The patient, a man in middle life, had upon two former occasions suffered from the initial symptoms of obstruction, but had been relieved by a simple cathartic. In his last attack the symptoms came after a dietary indiscretion. There were at first pain and bloating. The pain was sharp and crampy and referred more or less to the entire abdomen. The bloating was described as a feeling of fullness. Vomiting began on the second day and continued until death, following the operation. When I first saw him on the third or fourth day, his temperature was 99 plus, his pulse fair, and his general condition moderately good. He was vomiting frequently a dark, fæcal-smelling liquid and no effort to move the bowels had been successful. The pain had largely gone when I saw him, though he was generally tender over the abdomen. The meteorism was general and pronounced. He consented to an operation for relief. A median incision revealed an enormously dilated cæcum, ascending and transverse colon filling the abdomen; but a contracted sigmoid. The small bowels were empty. Thinking that I had a splenic flexure obstruction, I enlarged the incision and allowed the dilated colon to escape in order that I might more readily reach the involved portion of bowel. As the dilated bowel passed out of the wound, there was a loud report which proved to be due to the rupture of its peritoneal coat. I immediately introduced a trocar and canula and removed the distending gases and liquid. Examination revealed no mechanically obstructing agent. An appendicostomy was performed through a right-side puncture for the purpose of draining the colon. The peritoneal rent was sutured and the abdomen closed. The patient died during the second day. A post-mortem failed to show a single point of mechanical obstruction. The large bowels remained contracted, but the small were dilated with a gallon or more of liquid, and with some gas not in excessive quantity.

The most interesting feature of this case was the one of treatment. Had I performed appendicostomy immediately without allowing an escape of bowel and had I rested content with a simple digital exploration of the descending colon, my patient would, in all likelihood, have recovered. The dilation of the colon indicated that it was proximal to an obstruction and a simple drain of this bowel would have put the patient in the best possible condition for operation later, had the obstruction continued.

Two interesting points are raised by the findings. First, the vomiting must have been due to an antiperistalsis and not to an overflow backwards, as described first by Hageunot of Montpellier, or a "rückstoss," so called by Nothnagle. Second, the toxic obstruction was accompanied by an enormous gaseous distention; this, too, with sharp spasmodic pains, like that observed in mechanical obstruction. As the patient was not allowed to drink after operation, the fluid in the small bowels found on post-mortem must have been due to secretion or acute transudation, the result of the trauma of the operation.

Another of the toxic cases offered some interesting evidence in respect to treatment. The child, a girl six years old, began to suffer with crampy abdominal pains which she referred to the umbilical region, and for twenty-four hours her parents, thinking she had eaten something which upset her, tried the usual home cathartics for relief. The following day a physician was called, who in turn made every effort to move the bowels. He found the child suffering from sharp, colicy pains and vomiting. The next morning, seeing that the general condition was unimproved, even not so good as the day previous, he came for me to see the patient in consultation with him. I found the child still suffering, slightly bloated, without local meteorism, vomiting, no stooling, no temperature, pulse 120, and no definable local tenderness, but a diffuse soreness. I advised immediate operation, which induced the calling of a third consultant. It was then agreed by two of our number that still further effort be made to move the bowels by enemas, in hope an impacted fæcal mass might be washed away. The same evening I was called in again to find the only change from the condition noted in the morning was a pulse of 148. Again I asked to be allowed to operate and this time, backed by the two consultants, the parents consented. A right rectus incision was made, suspecting an appendix adhesion was probably the cause of the obstruction. No apparent obstruction was found, but instead, a mild catarrhal appendicitis, the appendix looking almost normal. The glands about the mesoappendix were enlarged and the appendix base slightly constricted. The appendix was removed and the finger used to search the abdomen for further trouble. As nothing was found, the wound was closed. Following the operation, the child grew better rapidly; the bowels opened on the second day. Improvement continued until the end of the week, when her pulse was in the eighties. Suddenly the bowel movement ceased, meteorism became marked, and the pulse rose to 150. Vomiting began and the condition looked critical. It was evident that there was a return of the obstructed condition and suspecting mischief near the appendix stump, I opened the abdomen by a crisscross incision.

Upon incising the peritoneum, a moderate amount of seropurulent fluid escaped. Some of this was caught and given to the pathologist for culture and staining. A suprapubic puncture was made and a glass tube introduced into the bottom of the pelvis. Through this, two or three ounces of the same fluid escaped. Next, the appendix area was examined and found to be in perfect shape. Knowing the utility of a drain of the bowels in these cases, I attached a distended loop of ileum to the wall at the point of the crisscross opening and packed the wound. The child was returned to bed and placed in a good Fowler position. Next morning, the condition was about the same, so I removed the pack and opened the bowel. A quantity of gas and liquid escaped. In short order, improvement began. The pathologist had reported in the meantime, that the fluid removed from the peritoneal cavity was sterile. In five days, the bowels opened through and through and the child made a nice recovery.

It might be argued that the original condition was reflex from the appendix, but the findings were against this, especially at the second

operation. The only explanation I can offer was an inhibitory intoxication. In this case no bowel exposure was allowed and all work was performed as rapidly as possible. There was, at the first operation, a very strong desire to carefully examine each portion of gut under vision. This, I feel, would have been a fatal error. My previous experiences taught me to exercise considerable care in exposing bowels which are obstructed.

The danger of a simple rectal injection to move the bowels, was illustrated by one of the toxic cases. A physician was called to see a middle-aged woman suffering from bowel obstruction and immediately proceeded to wash out the large bowel by enemas. The patient was placed in a knee chest position and a large injection given. She began shortly to vomit a quantity of fæcal-smelling fluid. The bowels, however, remained inactive and the enema did not return. She was brought to me at the hospital and an abdominal incision revealed a very large colon full of water, sagging into the pelvis. An appendicostomy was performed and a quantity of liquid, fæcal in odor and color, escaped through a catheter which was introduced through the appendix into the cæcum. She made an uninterrupted recovery. As a gallon or more of water was used in the rectal injection, none of which returned, and as the vomiting, which began immediately after its use was fæcal, it is most probable that the water was transmitted to the stomach and vomited.

There is no reason to believe a dilated cæcum, with inactive coats, might not allow a back flow of fluid through the ileo-cæcal valve. The experiments of Hess are conclusive as to the possibility of the small bowels acting in a reverse manner. He, it will be remembered, reversed the direction of a large portion of small bowel in a lower animal and after the healing, food taken by mouth was passed into the rectum and expelled.

In these cases of toxic obstruction, it would seem that the large bowel is first at fault and a cæcal drain has in my experience, been very effective in relieving the condition. That the small bowel may, in like manner, become inactive, following the trauma of an extensive operation, is shown by the first case I recorded, in which an appendicostomy, draining, and emptying the big bowel, failed to bring relief.

In cases of inactive colon, any water injected per rectum only adds fuel to the fire by filling the gut with a fluid which it does not expel. This carries the dilated transverse colon into the pelvis, thereby materially impeding the outflow, sharply bending it at the splenic and hepatic flexures, which portions are fixed.

Strangulated hernias offered better indications for their handling. When the patient's condition is good, there is no reason a resection may not be done, but when bad, nothing is as salutary as draining the bowels through the herniated dead gut. A secondary resection may be done when the fæcal absorption and intoxication are relieved. There are times, however, when there is doubt as to the viability of the gut. In four of my earlier cases, (three femoral hernias in women and one inguinal hernia in a man) there was a question as to the condition of the gut.

In these the darkened portion of bowel was returned to the abdominal cavity. All made a nice recovery. Lately I followed a procedure which is recognized as applicable in these conditions with a fatal termination. The patient, a healthy man in middle life, was brought to the hospital suffering from symptoms of obstruction which had existed four days. Examination revealed a small lump in the right femoral region which gave him no discomfort. The symptoms were classically those of obstruction. I made an incision over the lump and found a small knuckle of dark gut in the femoral canal. During the manipulation to free the sac, the knuckle slipped back into the abdominal cavity. I then made a low mid-rectus incision and found the altered section of gut. A portion about the size of a quarter of a dollar was quite dark, and this I invaginated, bringing healthy bowel serose into contact over it. A drain was introduced through the femoral canal to the peritoneum and the abdominal incision closed. For two days the patient did well, had free bowel evacuations several times and seemed to be progressing normally. The third day bloating began, he went from bad to worse and died on the seventh day. A post-mortem showed four feet of gangrenous gut. This condition can only be explained by sup-

posing the phlebitis extended from the original gangrenous area into the mesentery and progressively involved the gut supplied by the neighboring blood-vessels. I am satisfied, had I removed the small section of involved gut at the time of operation, the patient would have recovered. I call especial attention to this case, as I recently read an excellent article by Doctor Summers of Omaha, recommending this procedure in like cases. There are, it seems to me, but two courses for the operator when dealing with dead or seriously questionable portions of bowel; either reduce the knuckle into the wound, fix it there and drain by opening it, or resect at once. The patient's general condition will decide the proper course to pursue.

One of my cases of hernia which I opened "in situ" as suggested, died, not however as a direct result of the operation, but by drowning in his vomitus. I operated with the head high and cautioned the nurse to put him in a Fowler position in bed. This order was violated and as he recovered from the anæsthetic, he began to vomit. His head being low, a rapid escape of liquid from the stomach occurred which he inhaled. I was recalled to his room and pumped fully a quart of fæcal fluid from his lungs. His condition was extremely bad before this complication and it was impossible to resuscitate him. Attention has been called to this drowning by a number of writers and it needs no further comment.

In one of the hernial obstructions, I found the appendix and cæcum. The cæcum was in a fairly good condition, so I removed the appendix and reduced the hernia. Recovery was prompt.

One of the most difficult cases of the whole series, was an invagination of the ileo-cæcal junction up the colon, in an adult. This was some days old and could not be reduced. I finally resorted to a resection and the patient died following the operation. Resection was made difficult by a mass of unreducible bowel within the colon. This I removed by the method of Maunsell. I believe after my experience with that case, the wiser method of resection is to reduce as far as possible and clamp the bowel above and below the mass, taking the whole portion away. It is an error to try to save the segment of gut which surrounds the invaginated portion. The mesentery makes a difficult structure to handle when the portion of invaginated gut is rather long. The difficulty lies in avoiding injury to the mesentery supplying blood to the gut which is uninvaginated and should be saved. Those who have had to deal with like cases will recall the fact that the mesentery is drawn in with the invaginating gut almost to its base.

In the case of invagination of the ileo-cæcal cancer, the reduction was easily accomplished and resection presented no difficulty.

One of the most remarkable and instructive cases of these I record was one in which an inflamed appendix was found thrown over the jejunum and attached to the side of the jejunum mesentery. The young man had been suffering from obstruction one week when he came to me.

The attack commenced with a feeling of abdominal weight accompanied by crampy pains. A day or so prior to this, he had had a fall from his buggy and as he ascribed his symptoms, that of being sore, to the accident, he took some cathartic to open the bowels. This produced no result so he sought the aid of his physician. A diagnosis of either ptomaine poisoning or fæcal obstruction was made. Efforts made to move the bowels were unavailing. Four days after the onset of the trouble he began to vomit a dark fluid. I saw him on the seventh day of the attack. His pulse was strangely good, beating less than 100, and his temperature was 99 and a small fraction. His abdomen was somewhat rigid but not to a degree observed in acute inflammatory processes, the stomach was moderately distended, the small bowels gave no evidence of much gaseous distention. Local tenderness could perhaps be said to be greatest about the lower right side of the abdomen, but this was not marked. Auscultation revealed some high and some low pitched bowel peristaltic sounds, no tumor could be discovered and no symptoms to direct the operative route. His bowels being still inactive and the vomitus being fæcal, I advised operation, to which the patient consented. On opening the abdomen, a most interesting picture presented. The ileum and portion of jejunum were contracted

to half their normal size and were of the color of slate. The big bowel was normal in appearance, containing some gas. There was no excess of fluid in the peritoneal cavity. My finger easily detected a band stretched across the small bowel extending toward the appendix. The band proved to be the appendix bound in this position by having its tip tightly adherent to the side of the jejunal mesentery. The pressure from this appendiceal band obstructed the circulation in over one-half of the mesentery. I immediately broke up the adhesion and freed the appendix. The intestinal fluid began at once to pass on into the formerly obstructed bowel. In a very few moments, absorption of the toxic principles of these fluids caused the pulse to jump to 160. I removed the appendix and because of his bad condition, closed the abdomen without waiting to see how the circulation was re-establishing itself in the bowel coat. The patient made a steady and uneventful recovery.

This case offered no symptoms which would have made a preoperative diagnosis possible. The fæcal vomiting came from well up the jejunum and the abdomen, instead of being distended, was almost normal in measurement. The bowel proximal to the obstruction was full of fluid, but contained no gas. There was evident peristalsis as ascertained by auscultation but no fæcal movement had occurred for a week. The operation was done because of the continued vomiting and the impossibility to move the bowels. I expected simply to drain proximal to an inactive or obstructed portion of bowel. The operation was made more extensive by the necessary removal of the inflamed appendix. The rapid rise in the pulse, while alarming to a degree, was at least assuring of the return of circulation to the bowel coat and of the faculty of absorption. It was interesting to note with what wonderful rapidity the pulse went from the nineties to 160. I can account for the absolutely contracted condition of the small bowel in the area of obstructed circulation. The occlusion really occurred at the jejunum, while the circulation was interfered with in the mesentery from the point of adhesion to the base of the appendix. The ileum being open distally, the venous blood superinduced tonic contractions of its muscle coats, which emptied it. The color of the ileum suggested a long loop obstruction but its empty condition indicated, at most, only a partial occlusion at its distal end.

The case of obstruction arising from the adherent and constricting Meckel's diverticulum required a resection of four and one-half feet of gangrenous jejunum. The abdomen was full of foul-smelling bloody fluid. The gangrenous loop was distended with fluid and some little gas. Immediately upon opening the abdomen, the black bowel was brought through the wound and the living bowel packed back with large gauze sponges. Very little shock followed the resection and end to end anastomosis with a Murphy button. The introduction of a glass tube into the bottom of the cul-de-sac of Douglas and a good Fowler position in bed, enabled the patient to recover.

The dangers of post-operative adhesion of the small bowel to the lateral pelvic wall when drainage is applied along it, was illustrated by three cases in my list, with one death. Two of the cases recovered after an ileo-colon anastomosis. In another paper I wish to call attention to this danger of applying drainage from out the pelvic cavity along its lateral walls. The small bowels adhere to the immobile wall and this forms a very favorable condition for obstruction.

After reflecting upon the results I obtained in these cases of bowel obstruction, I am prepared to go to less extreme measures to bring about relief than formerly. I believe most of us are inclined to look too much at the mechanical side of the problem to the neglect of the physiologic. Even in strangulation by a hernial ring, the lumen of the bowel loop caught in the hernia does not suffer from complete closure, but rather is there a vascular obstruction. The bowel shut-off is as complete when its coat dies from a thrombotic process as when caught in a hernial ring. The real obstruction is one of function and not of pure mechanics. The danger to the patient arises from toxic absorption proximal to the infunctionate segment. With this in view, I have formulated for myself the cardinal principle of bowel drain. The method of obtaining this may vary as the conditions vary, but it is the part of wisdom never to tax the patient's

strength by long procedures, except in the few instances like the Meckel's diverticulum strangulation related above. If the condition is due to a band, invagination, hernia, etc., which admit of easy remedying, apply the method, but if the case is one of uncertainty or one which necessitates an exhaustive and dangerous procedure it is always better to let out the proximal bowel contents by an artificial opening, until the general toxic state is much improved, when a more radical measure might be adopted to bring permanent relief. Inflam matory obstructions clear up beautifully when the loop proximal to the involved segment is drained.

Neoplastic or granulomatous processes may be readily handled after sufficient drainage is given the bowel above the lesion. The danger lies in attempting a complete procedure at the one time. Why should one attempt to resect the bowel in a desperately ill patient when a strangulated hernia exists? A simple local anæsthetic opening will suffice to bring about relief from sufferings, physical and toxic. In a week the anastomosis becomes a matter of simple surgery. In one of my patients, a child of twelve years, obstruction became complete nearly three weeks after an operation for general peritonitis. I opened the abdomen only to find a conglomeration of bowel loops which to unravel would have probably caused death. I selected a portion of bowel which, because of its distention, was recognized as proximal to the obstruction and which, at the same time, seemed to be the most distal distended loop from the stomach. This was drained through a large rubber tube. In less than two weeks the fæcal movements were passing again by the natural route and the artificial opening was allowed to close. To this day, I am unaware of the exact position or nature of the obstruction, though I surmise, it was due to an inflammatory process in the neighborhood of the inflamed appendix, which organ initiated the primary disturbance.

Again, let me say of the treatment for obstruction, I believe success lies in seeking to drain rather than seeking to unravel the mechanical difficulty. When this latter can be done without adding a material chance of mortality, it is wise to adopt the measure, but when we must add to the danger of the condition by so doing, simply drain artificially. At a later time a serious condition will have become simple.

SOME OF THE PRINCIPLES OF INTESTINAL SUTURING[1]

By F. GREGORY CONNELL, M. D., Oshkosh, Wisconsin

I AM well aware of the marked honor shown me by your invitation to meet with you this evening, and I assure you it is deeply appreciated.

For a subject I have taken that large and suggestive one of intestinal surgery, but, because of its very extensive scope, I have chosen to speak only of intestinal suturing; not of any method or methods in particular, but of the subject taken as a whole, and of the principles involved in this most satisfactory branch of abdominal surgery.

The progressive advancement of intestinal suturing, since the advent of asceptic surgery to the present time, has been constant, and we may now disregard slight variations in operative procedures, and consider certain underlying principles common to all intestinal operations, which call for the closest study, and if borne in mind will afford substantial reason for anticipating a satisfactory outcome, regardless of the particular technique employed, or the pathological condition demanding its use.

In common with all operations, a comprehensive understanding of the anatomy of the part must be mastered before any surgical procedure may be properly carried out. The

[1] Read before the Chicago Surgical Society, April, 1909.

recognition of large or small bowel will usually be easy, a knowledge as to whether a mesentery may or may not be expected; the localization of a particular loop, or the differentiation of its proximal from its distal end, may be more than merely convenient.

As to the latter points, a study of the observations of George Monks, of Boston, will be of great aid.

But the anatomical point of most importance is the V-shaped space at the mesenteric attachment which results in a longitudinal strip of musculature being devoid of peritoneum. The serous layer surrounds the intestine in a manner similar to that of a cloth over a clothes line. There being a narrow longitudinal strip of intestinal wall at the concave border, the mesenteric attachment, that is not covered by peritoneum. In the intestine that has no mesentery this strip is broader and is the retroperitoneal portion. This particular formation results in a triangular space at the mesenteric attachment, with its base at the intestine, and its apex in the mesentery where both layers of the serosa blend.

In performing end to end or end to side enterorrhaphy, sero-serous apposition will not be obtained unless the stitches are made to include the serous coats at the mesenteric triangle, and therefore care should always be exercised to obliterate this space.

The blood supply must be carefully studied in intestinal surgery. The vessels originate at the root of the mesentery and divide many times within that structure before reaching the concave border of the bowel. The branching of these vessels is much more frequent as the distance from the origin of the jejunum is increased. At the mesenteric attachment the final branches (vasa recta) are given off; these encircle the bowel at right angle to its long axis, and being practically end arteries, their collateral circulation is imperfect.

In resection, the vessels of the portion to be removed must be traced to their origin. The nutrition of the ends to be sutured must not be interfered with. In wounds at the mesenteric attachment, if at all extensive, or if a perforation involves opposite sides of the gut-wall, resection is usually indicated, rather than repair of the wound or wounds, because of a possible interference with the nutrition of the convex border, as a result of the trauma and suturing. This convex or free border, that opposite to the mesenteric attachment, aptly referred to by Bishop as the "fundal line," is the weak point of the intestinal circumference, from the standpoint of nutrition, and should receive consideration as such. In complete division of the intestine the incision should always be directly at right angles, or at the expense of the convex, rather than the concave border, because the final branches originating at the mesenteric attachment encircle the bowel at right angle to its long axis, and being practically end arteries the collateral circulation is imperfect.

In resection, especially after obstruction, all of the diseased bowel should be thoroughly removed. Necrosis of the mucosa may be much more extensive than is apparent from a superficial examination of the external surface. Suturing must be done in normal tissue; disregard of this precaution is undoubtedly accountable for many failures following such operations.

Observation of this point will often obviate the necessity of uniting divided ends of unequal calibre.

As to how much of the bowel may be removed, we may say, as a general proposition, resect all that is necessary. The removal of two feet of bowel is of but little more seriousness than the removal of two inches, and much less so if the smaller resection necessitates suturing in tissues that are of questionable vitality. The resection of 18 feet by Brenner, of Wein, is the most extensive resection, followed by recovery, that I have been able to find in the literature.

Histology, rather than being of merely academic interest, is of the greatest practical importance. The submucosa and the serosa are intimately concerned in enterorrhaphy. It has been shown by Gross, and re-emphasized by Halsted, that the submucosa is the only layer capable of withstanding the pull of a stitch. The other layers offer practically no resistance.

The serosa, on the other hand, has no tensile strength, but is of great importance because of the plastic exudate which it throws out be-

tween the apposed inverted ends, which promptly seals the wound, prevents leakage, and causes early union.

Cleanliness, asepsis, always comparative, is a fundamental requisite of all surgery, and that of the intestine is no exception. This is best obtained by emptying the bowel. The experiments of Harvey Cushing, of Baltimore, are of interest, as they show that the stomach, duodenum, and upper part of the jejunum may be rendered practically aseptic by the ingestion of only sterile food, and by proper attention to the toilet of the teeth and buccal cavity. After delivery of the desired loop of bowel, and protection of the general peritoneal cavity, certain precautions are necessary to prevent the escape of intestinal contents during the subsequent operation; rubber-covered clamps with wide aperture are very commonly used for this purpose. Methods employing clamp and provisional suture aiming to absolutely prevent contamination of the serosa from the mucosa during enterorrhaphy have been presented recently.

After incision of the bowel the muscular coats contract and cause an eversion of the mucosa; this may sometimes cause confusion in the proper placing of stitches, but a little care will usually make unnecessary an excision of the redundant mucosa.

In case of damaged mesentery, in thrombosis or embolism of the mesenteric vessels, or of malignancy, the mesentery must be removed; in other cases the bowel may be separated from its mesentery.

In order to retain the divided bowel in proper position for suturing, rubber-covered clamps similar to those used in gastric surgery are frequently employed, but the tendency to simplify enterorrhaphy by the exclusion of mechanical contrivances and the substitution of needle and thread is well shown by the frequent use of suspending loops for this purpose.

An important phase of the problem of intestinal surgery, which has been the source of much discussion, is as to the best method of forming the union after enterectomy, by end to end, end to side, or side to side approximation. End to end is the preferable mode of procedure, but it may not be applicable, for example, where one cut end is not supplied with a mesentery; where one or both divided ends may not be brought into suitable position for suturing; or where the cut ends are of unequal calibre, also after gastroenterostomy "en Y," or other exclusion operations, in which one free end must be made continuous with the intestinal canal. Where there is merely a short circuiting of the intestinal current, i. e., lateral anastomosis, side to side apposition is then necessary. It may be stated that end to end union is the method of election in the hands of one trained in intestinal suturing, but in the hands of one unaccustomed to this line of work lateral anastomosis is the safer method. Lateral anastomosis has been recommended in cases of acute obstruction, because of the possible occurrence of thrombotic gangrene at the mesentery. But resection should not be followed by enterorrhaphy, either end to end or side to side, in case there is a probable occurrence of gangrene at the line of union. Additional bowel should be resected until all pathological tissue is removed, or an enterostomy should be performed.

In this connection it must be stated that a solution of continuity in the intestinal wall does not unequivocally demand immediate enterorrhaphy. In many instances artificial anus or fæcal fistula may be established as a temporary substitute for suture.

Drainage of the intensely toxic intestinal contents, above an acute obstruction, should be to a place out of the body rather than into the bowel below the seat of the obstruction, where it may be absorbed and cause death.

When *not* to do enterorrhaphy has been insufficiently emphasized in the past.

Another important question relates to the comparative advantages of the use of suture alone, mechanical contrivances, or aids to suture.

Mechanical contrivances, other than the Murphy Button, are of historic interest only. Aids on the form of elastic or twine ligatures, and various types of clamps have been quite extensively employed in performing lateral anastomosis or entero-enterostomy. Clamps and different forms ot provisional sutures or ligatures have, of late, been recommended as a method of preventing or diminishing contamination of the peritoneum during operation.

Consensus of opinion is markedly in favor of the simple suture; the important factors favoring this sentiment are: the improvement of abdominal technique in general, and the simplification of intestinal suturing in particular, joined with the fact that contrivances and aids are not always available.

Once again, a distinction must be made between one expert in the use of the needle and thread and one not so; in the hands of the latter the button is a much safer method.

Use of the suture demands practice, and no one should be allowed to perform abdominal section (with some possible exceptions, due to extenuating circumstances) who has not proven his ability to successfully perform enterorrhaphy upon the lower animals.

The requirements of the suture method are simple and concise; namely, a secure stitch holding the cut ends in sero-serous apposition.

In the primitive attempts an effort was made to unite the histological elements layer for layer, and while theoretically ideal, this was impracticable because of leakage.

The mucosa has been apposed to that of the other cut end, and has been brought into contact with either the fibrous or the serous layers, resulting likewise in defective union.

Fibro-fibrous and fibro-serous apposition is accomplished in stove piping, invagination, or other complicated methods, and has been successfully employed by a number of operators. As late as 1895 Greig Smith wrote under the title, "Is the Apposition of Peritoneum to Peritoneum a Surgical Error?" Experience has answered this question in the negative.

The basic principle which underlies all intestinal surgery to-day is that of sero-serous apposition, introduced in 1824 by Lembert, very shortly followed by Jobert, who accomplished the same result by invagination, and in turn followed by Denens, who employed foreign bodies for this purpose. As a result of sero-serous apposition there is a rapid union by plastic exudate from the endothelium, and a second important feature of this infolding of the cut margins, is the formation of a diaphragm which is effectual in preventing leakage.

In the history of intestinal surgery we find that in the ancient methods all layers of the wall were perforated. Then, changing to the other extreme, it was advocated that the suture should include the serosa only; next the serosa and the muscularis; later, that a satisfactory suture must include the serosa, the muscularis, and in addition, some part, but not the entire thickness, of the submucous layer. And finally, the stitch is again being made to include the entire thickness of the bowel wall.

As to the question of boldly penetrating all layers of the intestinal wall, or attempting to perforate but a part of the thickness of the bowel, there is a gradually increasing usage of the through and through stitch.

Its chief advantages are security and simplicity. Its disadvantage is the theoretical possibility of infection of the peritoneum by capillarity from the lumen.

It is now generally accepted that for a stitch to be secure it must include fibres of the submucosa. Gould claims that the muscularis mucosa must be included.

In explaining the introduction of intestinal sutures many writers have described the needle as penetrating, but not perforating, the submucous layer; and drawings elucidating this feat of intestinal surgery are common. At the 1901 meeting of the A. M. A. one of these drawings was reproduced and attention called to the fact that the submucous layer was magnified many times, but that the needle was not equally enlarged, thus conveying a markedly incorrect impression as to the relative ease with which such a suture might be placed.

With the needle magnified an equal number of times, as was the intestinal wall, it was found to be six times larger than was the submucous layer, into which it was supposed to penetrate but not perforate. Therefore, it may be said that the most important objection to the non-perforating stitch is that it is not secure.

The non-perforating stitch either *does not* include the submucosa, and is therefore insecure, or, *does* include this layer, and is then to all intents and purposes, a perforating stitch.

A suture, merely for the purpose of causing sero-serous apposition, may be non-perforating, and no attempt should be made to include the submucosa. The usual two-row method of uniting divided intestine, i. e., a deep row of perforating, and a superficial row of non-per-

forating stitches, is generally called the Czerny-Lembert stitch, but in reality is quite different from the method described by Czerny, but the changes have been so gradual that the name has been retained.

As to the advisability of using one, two, or more rows of stitches, general usage, at the present time, is in favor of the two-row method, but the single row is being employed more often. The use of three or more layers is no longer permissible; at one time this was common, but the establishment of the dictum of Murphy, i. e., a line of serous approximation is as good as half an inch; with the occurrence of obstruction due to the diaphragm formed by the excessive infolding of cut edges, and cases in which there was serious interference with the blood supply of that portion of the bowel between the stitches, all caused the one or two-row methods to become accepted as preferable.

Most operators look upon a second row of stitches as unessential, but use it as a safeguard A *properly* placed single line of stitches does not need a second line of apposition; an *improper* union, be it by one, two or more layers, does need re-enforcing stitches.

Secondary non-perforating stitches are often used to cover the knot of the perforating stitch when this is placed on the serosa.

The knot of the stitch may be located either on the serous surface, in the peritoneal cavity; on the serous surface, buried between apposed inverted ends; or on the mucosa, within the lumen of the bowel. In the ancient methods, the knot was located outside of the peritoneal cavity by attaching the line of suture to the parietal peritoneum; at the present time, the knot is again being located outside of the peritoneal cavity, within the lumen of the bowel.

Placing the knot within the peritoneal cavity is objectionable because of its action as a foreign body, and as one-half of the knot has frequently (often unwittingly) passed through the lumen, it may be the source of infection. With the knot on the mucosa the entire suture is practically extraperitoneal, with drainage into the lumen.

In most suture methods in vogue at this time, part of the sutures are knotted in the lumen, those not so situated being covered with a sero-muscular secondary stitch.

All of the knots of an enterorrhaphy may be placed within the lumen of the bowel.

There is a choice between stitches that are knotted on the side or on the top of the seam. In the former, square or right angle stitch, the inverted ends are secured as by a staple, and the slipping of one cut end by the other is impossible. With the circular stitch, which passes over, or is tied on the top of the line of union, the inverted ends are free within the loop formed by the stitch, and may slip by each other, resulting in a sero-mucous apposition. The suture material must not be too fine, as it may cut through the wall when drawn taut.

In general surgery, absorbable material is to be preferred when stitches are not to be removed. But in intestinal work, as the great majority of the stitches communicate with the lumen, the danger of a possible rapid absorption by the digestive juices, contraindicates the use of absorbable material.

Either Pagenstecker's linen, some modification, or silk is the usual material. The tendency of all intestinal stitches is to migrate through the intestinal wall into the lumen, where they are eliminated in the fœcal current, so that the advantage of absorbable material in this location is not great. A non-absorbable suture, attached at one or more points, may hang into the lumen for considerable space of time, but, in the human subject, practically never causes symptoms.

When two layers of suture are employed, the deep perforating row, for security, should be non-absorbable; while the superficial, sero-muscular layer, for serous apposition, may be of catgut.

Capillarity of intestinal sutures is a subject that has been given a great deal of consideration. Because of the supposedly less capillary properties of Pagenstecker's celluloid linen, this, or its modifications, has, to a large extent, replaced the use of silk. But recent experiments have shown that there is practically no difference in capillarity between these materials after they have been in contact with the mucosa; that the danger of

peritoneal infection by capillarity in intestinal suturing has been greatly exaggerated; and that such a fear has little substantial basis.

The continuous and interrupted sutures are both followed by success, but there are many advantages claimed for either. The continuous is advantageous in time saving and in hæmostatic properties, and is disadvantageous in that there may be puckering; and if the suture yields at any one place, the entire line of suturing is weakened, and in the process of elimination, a thread attached to the wall may hang into the lumen.

With the completion of enterorrhaphy after any method, imperfections should be looked for; if suspicious spots are found, these must be re-enforced by secondary stitches.

Drainage is rarely indicated after enterorrhaphy, unless the peritoneum has been extensively soiled. But when drainage is employed, one all important point to be remembered is to place the drain adjacent to, but not in contact with, the suture line.

The danger of yielding is slight, with perforating stitches; the danger of leakage is removed by the valve-like action of the diaphragm formed by the inverted edges. The danger of peritoneal infection by capillarity is small. The peritoneal portion of the suture is surrounded and shut off from the general peritoneal cavity by serous exudate within a few hours.

Consistent after-treatment presupposes, at least, a familiarity with the histology of intestinal repair, from which we might rationally suppose that rest is essential in the early stages of repair so as not to interfere with proper serous exudation. Cannon and Murphy have demonstrated by their classic experiments that this is not only a correct supposition, but also that nature insists upon such rest, by the pyloric sphincter preventing the passage of any gastric contents into the intestine for about six hours after enterorrhaphy. The fact that six hours is recognized as ample time for firm sero-serous sealing to take place is very significant.

The points that have been considered this evening concern chiefly the technical phase of intestinal suturing. Innumerable other conditions will be met with before, during, and after operation that will demand deep study. A knowledge as to these points, and the ability to arrive promptly at the correct decision, is of equal importance with technical skill, for the reason that a false step or conclusion regarding any one of them may render futile a technically perfect enterorrhaphy.

Such knowledge demands a high degree of something called surgical judgment, which can only be acquired after extensive experience founded upon a comprehensive understanding of pathology in all its branches. And it is just this surgical judgment that elevates the intestinal surgeon above a mere tailor of human tissue.

THE COLICS OF THE VERMIFORM APPENDIX

By WELLER VAN HOOK, A. B., M. D., Chicago, Illinois

THE hollow organs in which fluids are stored or through which they flow are, as a rule, provided with a propulsive apparatus which has two essential parts, a muscular and an elastic apparatus. The former, during the systolic or analogous state supplies force; the latter during the diastolic condition stores and utilizes it. The musculature undergoes, so long as it has not, itself, suffered damage, an hypertrophy or atrophy proportionate to its needs. The elastic apparatus is capable of undergoing similar changes. In each case, failure of adjustment results in a permanent alteration of structure with great injury to function.

The sudden increase of pressure within these organs results in pains, depression, or collapse, owing to injury of the nerve-endings or nerve-trunks.

Colics are those seizures of pain, crises of

depression and collapse, which are due to the sudden increase of pressure within these hollow organs.

The abdominal organs are especially subject to these attacks, and an extended clinical acquaintance with them is the only safeguard against serious errors in their diagnosis and treatment. The colics of the abdominal hollow organs present symptoms common to all in pain which is characterized by spasmodic action, the so-called cramping pains, the occurrence of rigidity of the abdominal walls, and secondly the various symptoms due to the intimate association of the hollow organs with the sympathetic nervous system, resulting in collapse. The organs which can be affected by colic in the abdomen are almost too numerous to mention; all parts of the gastrointestinal tube, excretory ducts of the liver, pancreas, kidneys, and bladder, not to mention the spasms which affect the uterus and its appendixes.

The colics of the vermiform appendix were first distinctly referred to, so far as the writer is aware without thoroughly reviewing the literature, by V. Hochstetter,[1] who wrote upon the subject nearly twenty years ago.

The causes of colics of the vermiform appendix are always due to some form of obstruction. One of the most valuable papers ever written on the colics of the vermiform appendix was by Hansemann of Berlin, who, a number of years ago, published an account of some 400 autopsies which he had performed on cases where the vermiform appendix was very carefully examined, particularly where disease of the organ had occurred. He found that the predisposing cause of appendicitis was practically always some obstruction to its outlet into the large intestine, or the presence of a foreign body.

Foreign bodies found in the appendix are almost always present because of the slight obstruction to the outflow of secretion and the discharge of bodies which have, in a certain sense, wandered into the tube. For, if the outlet is perfectly free, even a comparatively large foreign body can be easily extended, owing to the powerful musculature of the appendix, which suffices to extrude even such a large article as a capsule or small bean.

[1] Billroth's Festschrift, 1892.

The forms of obstruction which can occur here are extrinsic and intrinsic.

Of the extrinsic causes, we have especially adhesions, the pressure of neighboring organs or of tumors, and particularly those congenital peculiarities of the organs which are so frequent, due to the comparative immobility of the cæcum and the freedom of movement of the appendix itself, allowing the appendix to float easily in the abdominal cavity, while at its base it is so closely held down that it cannot easily empty itself on account of the quasi constriction at its neck.

The intrinsic causes of obstruction are almost too numerous to be catalogued.

Congenital stenosis occurs quite commonly; it seems that there is almost a valve-like narrowing of the mouth of the appendix, and that this is structural in character and its resistant must be overcome by the muscular action of the walls of the appendix itself.

Scars are next in order; very numerous and very difficult to encounter. They are due to antecedent inflammatory action caused by mild forms of appendicitis which may occur as the result of lymphatic infection, which may in turn be due to most trivial causes.

The symptoms of colic of the appendix are sudden colicky pains in the abdomen without elevation of temperature; if the temperature is elevated, it may be properly argued that there are inflammatory processes going on and the case belongs no longer to the category of simple colics. Of course, almost all cases of appendicitis are associated with violent colic, but the object of this paper is to speak only of those cases in which the inflammatory element is wanting.

The pain in these cases is caused by the rigidity of the abdominal wall, which is protective in character, and also with the general symptoms of depression of the sympathetic nervous system. This may go to such a length that the collapse is not to be distinguished from that of an acute inflammatory process of great violence. Hence the beginner may feel that, if he has not removed the appendix in the early states of an attack and if no elevation of temperature has arisen, he has mistaken the nature of the disease, and that the trouble was not connected at all with the appendix.

As a rule the attacks of colic are recurrent, and the patient who has once suffered from such a condition speedily recognizes, after a few of the attacks have occurred, that they are typical in character and are almost exactly alike. He learns soon that the pain first seems to involve the whole abdomen and soon becomes concentrated about the appendix, passing off in a few hours or days, leaving a soreness in the location of the appendix.

The writer, operating on these cases in the earlier days, was frequently chagrined to find that no very marked changes were to be found in the appendix. The failure to find changes that will explain these attacks of repeated colic is due to the fact that frequently the alteration that produced the stenosis is outside of the appendix itself in the wall of the cæcum, as was done by Hansemann.

The diagnosis of colic of the vermiform appendix as distinguished from colics of neighboring viscera is not difficult, especially after two or three of the mild attacks have occurred. The symptoms already referred to are quite characteristic, except in those instances where the appendix does not lie in the usual position but occupies a site far back and against the muscular abdominal wall or lies deeply in the pelvis. In these cases, while the patient has pain of the colicky kind which recurs more or less frequently, he does not necessarily have rigidity of the abdominal wall. This results from the fact that the nerves, irritation of which brings about reflex contraction of the abdominal wall are in such cases free from insult on account of the position of the appendix. Here other symptoms may be present, as for example, pain along the ileo-inguinal nerve, giving rise to some of the signs of ureteral obstruction. In cases of this kind distinction is made by a brief observation of the case, which demonstrates, in the case of vermiform colic, that no red blood corpuscles are present and that, consequently, no injury has occurred to the excretory duct of the kidney.

A remote symptom of these lesions of the appendix is to be found in many cases in catarrh of the colon; a mucous colitis is observed in some of these cases and it is sometimes relieved by the removal of the appendix.

When a diagnosis of colic of the vermiform appendix has been made it is wise to remove the obstruction inasmuch as recurring attacks are likely sooner or later to be associated with infection, when of course true appendicitis is to be diagnosticated. Indeed many cases of appendicitis can, by a little inquiry, be found to have been long preceded by recurring attacks of slight colic. In these cases of colic, it is never safe to diagnosticate the presence of a stone or of adhesions. It is wise to recognize that a slight obstruction is always present, furthermore, that this obstruction in many instances will not be found by inspecting the appendix. But the most important thing is that the removal of the appendix does away with the disease and leaves the patient again in health.

These cases, like those of appendicitis without infection of the peritoneum, are especially adapted to the operation by small incisions which the writer has so frequently advocated.

THE TREATMENT OF TETANUS

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AN understanding of the pathology of tetanus is the key to treatment. The tetanus bacillus was discovered by Nicolaier in 1884, but was first obtained in pure culture by Kitasato in 1889. The organism is strictly anærobic, and one of the few anærobes that are known to be pathogenic to man. Wound conditions of such a character that infectious material is carried deeply into the tissues, to the exclusion of oxygen, are necessary for the development of the germs. A mixed infection with pus organisms tends to favor the growth still further by abstracting the oxygen from the tissues, and by producing a local necrosis. Experimentally it was shown that small amounts of a pure

culture could be injected without results, whereas if associated with staphylococci, much smaller doses sufficed to produce symptoms. Tetanus organisms are not propagated by passing from case to case, but they spend the greater part of their career outside of the human body in some other host, or as harmless saprophytes. Their frequent occurrence in horse manure leads to the question whether they are normal inhabitants of the horse's intestine. They are notoriously resistant; heating to 80° centigrade does not kill the spores; the bacilli survive boiling for one minute, and are not destroyed by five per cent carbolic acid in ten hours. The spores live indefinitely in the dry state. Therefore considering its ubiquity, its resistance, and its virulence, there is only one factor that prevents the disease from becoming epidemic, namely, its anærobic character.

The bacilli remain at the point of infection frequently in such small numbers as not to be demonstrable, and it is unusual to find them in the blood or in remote organs. Diphtheria presents the closest analogy to tetanus, in that in both the germs remain localized and evolve a toxin which produces the clinical symptoms. They differ radically, however, in the way the toxin is disseminated. Diphtheria toxin circulates in the blood, and is accessible to serum injections, as shown by the ideal results of antitoxin treatment. Tetanotoxin, on the other hand, does not continue to circulate free to any extent, but early becomes inaccessibly combined with certain nervous elements and cannot be reached by any known remedy, no matter how administered. That is why the antitoxin, though proven an antidote in the laboratory, has been so disappointing clinically. No matter how administered, it cannot reach the toxin to neutralize it.

Though the number of bacilli in the wound may be small, the amount of toxin produced is relatively great. The latter is remarkably poisonous; one three-hundredth of a grain is a fatal dose for man (Brieger). It has a particular affinity for the ganglion cells in the anterior horn of the spinal cord, and for the nuclei in the medulla. The toxin diffuses through the tissues around the point of infection, and Meyer and Ransom have shown how it enters the end of the motor neuron where it is not provided with a myelin sheath. The myelin sheath offers an absolutely impervious insulation, impenetrable alike both by the toxin and antitoxin. The toxin cannot enter an injured nerve save at its termination, neither can the antitoxin. Gumprecht proved that the motor nerves, and not the sensory, are the conductors of the toxin to the cord and medulla. Nor does it pass up in the lymph spaces about the nerve, but always by way of the axis cylinders. On reaching the cord, it enters into a union with the motor ganglion cells. By way of the commissure it diffuses to the other side of the cord, thence it passes upwards along the motor tracts. Another portion of the toxin is taken up by the lymph and blood from the wound, and thus gets into general circulation. Motor nerve endings throughout the body then take up the toxin from the tissue juices, and convey it to the cord. Thus the cord is soon being saturated with toxin both from the motor nerves leading from the original wound, and from all the spinal and cranial motor nerves. As the toxin is known to reach the cord by way of the motor nerves exclusively, is it not natural to infer that such portion of it as passes up a short nerve will reach the ganglia first, and produce the first symptoms? Thus, before the poison can reach the cord by way of the long nerves in the extremities, another portion of the same has entered the circulation, found access to the endings of a short motor nerve, like the inferior maxillary branch of the trifacial, reached the cord first and elicited the first symptom, namely trismus. This looks like a plausible theory to explain the occurrence of trismus as the first motor symptom, no matter where the primary infection is situated on the body. This is in harmony with the clinical findings in local forms of tetanus, involving a single extremity, or in head tetanus. In local tetanus, the infection is of a mild character; there is enough toxin produced to involve a section of the cord through the motor nerves leading from the wound, but not enough to get into the general circulation, at least not for a relatively long period. Thus, we have in this form of tetanus primarily an involvement of certain muscle groups in the extremities, with trismus and general spasms later, if at all. The period of

incubation is long, because the toxin all has to pass up some long nerve in an extremity, and not enough gets into general circulation to make the short cut mentioned above. These local cases are mild as a rule, and generally all recover.

The period of incubation in tetanus represents the time required for the bacilli to produce their toxin, and for the toxin to reach the cord and evoke the first motor phenomena. A short period of incubation indicated that there is a virulent infection, and that toxin is present in quantity, that the tissue juices contain it at an early stage, and that motor nerves throughout the body are conveying the poison rapidly to all portions of the cord. The longer the period of incubation, the milder will be the type of the disease.

The toxin enters into some sort of a firm combination with the nerve cells of the anterior horn and nuclei of the medulla. Whether this is due to its affinity for the cholesterin constituent of the cell is an open question. At any rate once the union has taken place, there is no remedy able to break it up and neutralize the toxin even if it could be reached by the antitoxin, and it has already been shown that this is not possible. The axis cylinders and motor nerve cells are as effectively out of reach of the antitoxin circulating in the tissue juices, as are the wires of the Atlantic cable insulated from the salt water.

To facilitate classification, tetanus is divided into acute and chronic forms. Acute cases have an incubation of ten days or under, and chronic (or subacute) cases have a latent period of ten days or over.

TREATMENT OF TETANUS

The available tetanus statistics, from the very nature of the subject, are unreliable, and show a lack of uniformity. Tetanus is comparatively rare after all, and no one observer has had enough cases in a year or series of years available for purposes of comparison under like conditions. Series of cases are collated from scattered reports, often incomplete. Recoveries will get into the literature oftener than deaths. Chronic cases that get well anyway are hailed as recoveries due to some special method of treatment.

The characteristic feature of tetanus is that by the time you have made the earliest possible clinical diagnosis from the appearance of rigidity, it is already practically too late for treatment, at least for serum treatment. Every motor nerve in the body is loaded with toxin, and conveying it to the cord. That means that if there is a fatal dose then on the way in these various nerves, no treatment, no matter what it is, can save life. Aside from prophylaxis, then, what is the problem? As soon as the diagnosis can be made, the indications for treatment are as follows:

1. Remove the source of further toxin supply, by treatment of the atrium of infection.
2. Neutralize the toxin contained in the tissue juices by massive injections of antitoxin subcutaneously.
3. Employ some remedy to allay the reflex excitability of the spinal cord.
4. Nourish and stimulate the patient, and tide him along until such a time when the toxin shall have been eliminated from the nervous system.

Prophylactic treatment.. As a prophylactic remedy tetanus antitoxin is conceded to be of undisputed value, as proven by animal experimentation, and in practice. It has been used in veterinary surgery most consistently, and with positive results. Thus, Nocard injected 2,700 horses, and no case developed among them, while of a similar series, not immunized, 259 developes tetanus. ¶In many clinics and hospitals immunizing doses of antitoxin are being given in case of all suspicious wounds, notably Fourth of July injuries. As antitoxin is absorbed very slowly when injected subcutaneously, Rogers recommends the intravenous method. Injections should be made about the wound into the muscles and tissues, to neutralize the toxin formed before the nerves can take it up. To be safe, injections should be repeated several times weekly for several weeks, as the antitoxin is being continually eliminated. While tetanus cannot thus be invariably averted, yet, if it does develop, the period of incubation will be longer, and the cases are generally mild, and recover. It is needless to add that to be most effective, the immunizing doses must be injected at once after injury. Suter had twelve cases develop

in spite of serum treatment, but only two died. This subject was discussed at the German Surgical Congress of 1906. Baer reported fifteen cases of tetanus developing after prophylaxis of which four died. Krafft stated that an inquiry among one hundred French surgeons showed that twenty-one had seen tetanus develop under like circumstances. It was the consensus of opinion of the surgeons present, that its value in prophylaxis had been amply shown. It is needless to add that proper wound treatment is essential to prophylaxis in conjunction with the serum.

Curative treatment involves the following:

1. Local wound treatment.
2. Antitoxin treatment.
3. Spinal injection of magnesium sulphate, eucain-morphine, etc.
4. General measures, as food, medicine, proctoclysis, and nursing.

1. *Local wound treatment.* In the care of wounds, much more can be done in the way of prevention than of cure, when the disease is already developed. Bearing in mind the anærobic feature, such wounds as Fourth of July injuries, compound fractures, gunshot and punctured wounds, street car injuries and the like, should be treated with a view of creating conditions in the wound, as unfavorable as possible for the tetanus bacilli. To provide access of oxygen to all parts of the wound would suffice. In the Russo-Japanese war the Russians treated their wounds aseptically and had more cases of tetanus than the Japanese, who treated theirs antiseptically, notably with balsam of Peru.

Such general principles as the following should be observed notably with a view of prevention, viz.:

1. Leave no foreign substances of any character in remote recesses of the wound.
2. Allow the wound to remain open, or enlarge it if necessary to secure good drainage.
3. Avoid escharotics or the cautery, or anything that will produce an eschar, as under the scab, conditions are ripe for the development of bacilli.
4. Remove such tissues as are obviously destined to necrosis, especially such tissues into which dirt has been ground.
5. Avoid dusting powders and iodoform gauze plugs that prevent the escape of wound secretions. Gutta percha or cigarette drains and moist dressings are much to be preferred. The sealing of punctured wounds with adhesive plaster, collodion, or any of the much exploited antiseptic clays, is to be condemned.

The use of peroxide of hydrogen is rational, owing to the liberation of oxygen.

Finally, special mention should be made of balsam of Peru. Experiments have been made with this substance which are very promising. Bockenheimer, in the Archiv. f. Klin. Chir., bd. 86, heft 2, details some interesting experiments made with fatty substances. There are certain chemical substances which have an affinity for toxins. Snake venom is neutralized by the cholesterin contained in the ox-gall which the Indians applied as an antidote. This led Bockenheimer to try fatty substances in cases of tetanus. In the experiments about to be detailed, he used liquid and solid fats, with better results from the latter. The best results were obtained with balsam of Peru. The work was carefully done in the von Bergmann clinic, and is above criticism.

Guinea pigs were inoculated with infected splinters of wood, and then treated locally with balsam, by external application and by injection. According to the time allowed to elapse after infection, and before treatment was begun, the animals either ran a mild form of the disease, or at least survived a much longer time than the control animals, which invariably died. In some cases the disease was prevented entirely by early application.

Adding antitoxin to the balsam did not increase its effectiveness. Thus, balsam of Peru, a remedy readily available, was shown to have a counteracting effect on tetanus toxin, a discovery of no small importance. For this reason the use of the balsam in all suspicious wounds, in addition to the other measures mentioned, may serve the purpose of prevention. Whether these fatty substances contain cholesterin which unites with the toxin, as in the case of the nerve cells, remains to be definitely determined.

2. *Antitoxin treatment.* Antitoxin, in spite of its great experimental efficiency in animals, and its undisputed value as a prophylactic, has so far proven extremely disappointing as a

curative agent, when the disease was fully developed. The reason for this can be readily appreciated when it is borne in mind that tetanus antitoxin, no matter how administered, can neutralize only that portion of toxin free and uncombined in the blood and lymph. It is immaterial how given, whether subcutaneously, intramuscularly, intracerebrally, intravenously, subdurally, intraneurally, into the cord, it matters little how, the result is the same. It circulates in the blood, neutralizes such toxin as may be contained there, and is excreted from the body. None of it reaches the nerve cell where the toxin is locked up, and it is not certain whether it could break up the union if it were able to reach the spot. By the time a clinical diagnosis is made and the remedy administered, there may already be a fatal dose in the nervous system, beyond the reach of any specific remedy. For this reason antitoxin has proven of little use as a curative agent.

Von Manteuffel, as the result of a large experience in the Russo-Japanese war, declares that antitoxin is useless as a therapeutic agent. Bockenheimer has recently reviewed the material of von Bergmann's clinic, and concluded that antitoxin, no matter how injected, gave no results. Relatively many intracerebral injections were made, and death hastened thereby. There were nine cases treated without antitoxin, with a mortality of 88 per cent, and twenty were injected, with a mortality of 85 per cent.

Suter reports 137 cases injected, with a mortality of 85.7 per cent for the acute cases and 34.9 per cent for the chronic. Busch, of Koerte's clinic, injected thirty cases, with 70 per cent deaths. Antitoxin did not lower the mortality in that hospital. Rose collected 124 cases in the Krankenhaus Bethanien, with 83.8 per cent deaths in spite of antitoxin. Pfeiffer treated 93 cases with antitoxin, and 14 cases without it, with about the same mortality, viz.: 50 per cent.

Trendelenburg, Riedel, Kroenlein, Bornhaupt and Holbeck could see no benefit derived from the use of any method of antitoxin injections. I consider opinions emanating from large clinics, as quoted above, as nearer the truth than the results of compilations of scattered reports. There follow, however, the reports of various authorities:

Engelman, 54 cases treated with antitoxin, 28 per cent mortality.

Kohler, 42 cases treated with antitoxin, 43 per cent mortality.

Holsti, 171 cases treated with antitoxin, 41 per cent mortality.

Steuer, 311 cases treated with antitoxin, 43 per cent mortality.

Ullrich, 72 cases treated with antitoxin, 72 per cent mortality.

Busch, 54 cases treated with antitoxin, 66 per cent mortality.

Pfeiffer, 93 cases treated with antitoxin, 53 per cent mortality.

Lambert, 124 cases treated with antitoxin, 72 per cent mortality.

Brandenstein, 26 cases treated with antitoxin, 82.3 per cent mortality.

For the purpose of comparison, there is added a table of statistics compiled before the era of antitoxin.

Curschman, 912 cases, 44.6 per cent mortality.

Friedreich, 252 cases, 50.7 per cent mortality.

Hobart, 290 cases, 34 per cent mortality.

Worthington, 68 cases, 41 per cent mortality.

Various modes of injection have been brought forward from time to time, always with the hope that the remedy was being introduced more directly into the nervous system. These hopes have not been realized, however.

Cerebral injections, as first practiced by Roux and Borel, have been found entirely too dangerous and formidable a method of introducing the remedy. Whether injected into the brain substance, or into the ventricles, the serum never reaches the cells in the medulla or cord. The only visible effect is a more hasty death.

Lumbar puncture held out some promise, however, the antitoxin thus injected is just as remote from the cells in the cord as though given subcutaneously. There is no toxin in the cerebrospinal fluid to be neutralized. The remedy, when injected, passes from the cerebrospinal fluid into the general circulation and is excreted. Abrading the cauda

equina with the injecting needle makes no appreciable difference, as only a very few axis cylinders are thus exposed. Injections directly into the cord are too dangerous, even if they had any proven value.

Meyer and Ransom were the authors of the intraneural injection method, which looked promising, as it was known that inasmuch as the toxin passed up the motor nerves, its progress might be blocked by serum injections directly into the main motor nerves leading from the seat of infection. The nerves are exposed and injected until they are several times their normal size; this is repeated on successive days. The method has not proven of much value, although some favorable cases have been reported by Rodgers, Schley, and others. None of the cases of my series so treated recovered.

The reason is obvious; even when injected directly into the nerve, the serum does not reach the axis cylinders to any appreciable extent, but is disseminated in the lymph spaces around the nerve fibers. Only those few nerve fibers which happen to be injured by the needle point have their axis cylinders exposed to the action of the antitoxin. The effect is too infinitesimal to be considered.

Thus, a knowledge of the pathology has shown why all of these special injection methods have failed clinically, and are no better than the subcutaneous method. For, after all, all that can be hoped from the antitoxin is to neutralize the free toxin in the circulation. If there is not already a fatal dose in the nervous system, the patient will get well.

3. *Spinal anæsthesia.* J. B. Murphy, in 1904, first successfully treated a case of acute tetanus by aspiration of cerebrospinal fluid and injection of eucain-morphine by lumbar puncture. I believe that along this line, aided by antitoxin and other general measures, tetanus can be most successfully combated. Tetanus patients die either of exhaustion due to long-continued tonic and clonic spasms, inability to take food and drink, or from paralysis of the heart and respiratory centers, the result of the action of the toxin. Those cases where these vital centers are early involved cannot get well under any treatment. However, in a large proportion of cases, if we can cut off further influx of toxin into the nervous system, and eliminate the spasms, the patients will recover.

S. J. Melzer, in 1905, first published the results of his experiments with magnesium sulphate. "Intraspinal injections of magnesium sulphate in doses which do not affect the respiratory or heart center, are capable of abolishing completely all clonic convulsions and tonic contractions in cases of human tetanus and experimental tetanus in monkeys. The relaxing effects of the injection may last twenty-four hours or longer. Subcutaneous and intravenous injections are accompanied by symptoms due to the depressing effect of the drug upon the higher centers of the cerebrum and medulla. Therefore, for therapeutic purposes, the intraspinal method is the best. There may be some variation of the action of magnesium sulphate in different individuals. The same dose will produce in some a more marked effect than in others. Women and children are more susceptible than men, and require smaller doses relatively to their weight." The dosage has been arrived at experimentally as follows: Of a 25 per cent sterile solution of magnesium sulphate, 1 c. c. is injected by lumbar puncture for every twenty pounds body weight in men. For women and children, the proportion is one c. c. solution for every twenty-five pounds of body weight. It is best, with the first injection, to be very cautious and ascertain the tolerance to the drug. The initial dose should be rather smaller than the average just given, for if too large, it will result in paralysis of the heart and respiratory centers. It is probable that one case of my series, a boy, died of this cause. It is important to bear in mind that the use of magnesium sulphate is accompanied by positive danger, unless strict precautions and judgment are exercised in its employment.

After the injection, within fifteen or thirty minutes, the spasms and muscular rigidity begin to relax. The exaggerated reflexes begin to abate, and are finally abolished. The opisthotonos disappears, and the limbs and jaws relax, and can be moved actively and passively without eliciting a fresh outbreak as before. The pains are relieved, and altogether the patient is transferred from an exceedingly

distressing condition to one of relative comfort. He takes nourishment and enjoys refreshing sleep. The respite thus obtained will continue for about twenty-four to thirty-six hours, during which time the patient has been fortified against the renewal of the spasms. As soon as the rigidity and convulsions begin again to become a menace, the lumbar injection can be repeated. The dosage should each time be carefully estimated by a consideration of the intensity and duration of its effect on the patient. The injection should be made slowly, after having observed the usual precaution, and it is not material that any amount of cerebrospinal fluid be withdrawn. The injections can be repeated as indicated without limitations as to number, becoming less frequent as the symptoms abate. It is truly marvelous to see a patient transformed by this remedy from a condition of acute tetanus and all that this implies, to a state of placid comfort. I am convinced that along this line of treatment lies our only hope of saving the lives of many of these otherwise hopeless patients.

Robert T. Miller (American Journal of the Medical Sciences, December, 1908) collected reports of fourteen cases of tetanus treated with magnesium sulphate, of which eleven were given subarachnoid injections. Of these eleven cases, five recovered. Adding the author's two cases would make thirteen cases, with six recoveries. These cases were all of the very acute variety, and would practically have all died under the ordinary treatment.

Miller very properly calls attention to the paralyzing effect of the magnesium sulphate on the heart and respiratory centers. Several of the cases were given too large an initial and succeeding doses, and showed the toxic effect of the drug, and, at least two died of respiratory failure, the effect of the injection. The respiration in some of the cases sank to four or five in the minute.

4. *General and medicinal treatment.* Along with the antitoxin and magnesium sulphate, we must employ every available agent that may be of service. Of importance are quiet hygienic surroundings, and good nursing; plenty of easily digested food, and much water should

AUTHOR'S CASES

		Age	Source of Infection	Incubation	Treatment	Result	Remarks
1	Male	45	Nail puncture of hand	10 days	Antitoxin subcutaneously and medical	Death on third day	
2	Male	12	Blank cartridge wound of hand	7 days	Medical (chloral, bromides, etc.)	Death on third day	Rigidity of infected arm most marked
3	Male	45	Nail puncture of hand	15 days	Medical	Recovery	
4	Male	15	Toy pistol wound of hand	6 days	Subcutaneous antitoxin chl. and bromides i. n. injection	Death on third day	Brachial plexus exposed and injected
5	Male	34	Cut hand on broken bottle in a stable	7 days	Intraneural injections brachial plexus	Death on fourth day	
6	Male	8	Splinter of wood in foot	6 days	Subcutaneous antitoxin	Death second day	
7	Male	40	Gunshot wound of chest	8 days	Subcutaneous antitoxin	Death third day	Tonic and clonic convulsions, moderate, severe
8	Male	43	Nail puncture of foot	3 weeks	Medical	Recovery	
9	Male	13	Stepped on garden rake	9 days	Subcutaneous antitoxin	Death 5th day	
10	Male	44	Nail puncture of foot	14 days	Medical	Recovery	Trismus and convulsions, moderate
11	Male	25	Nail puncture of foot	12 days	Medical	Death 7th day	
12	Male	50	Nail puncture of foot	3 weeks	Medical	Recovery	Trismus mild, neck stiff, not confined to bed
13	Male	53	Gunshot of leg	5 days	Subcutaneous antitoxin	Death 2d day	Continuous and severe convulsions. Death from asphyxiation
14	Male	8	Nail puncture of foot	6 days	Subcutaneous antitoxin. Magnesium sulphate by lumbar puncture	Death 4th day	Did not die in convulsions. Possibly 3 c. c. of 25 per cent mag. sulphate was an overdose. He died of heart paralysis; weight about 60 lbs.
15	Male	13	Compound fracture of leg	7 days	Subcutaneous antitoxin. Intraneural in sciatic nerve. Seven lumbar punctures, and injection 4–5 c. c. magnesium sulphate solution. Chloral and bromides, magnesium sulphate hypodermically, 165,000 units of antitoxin were injected	Recovery	

be given. Attention to the bowels is essential and proctoclysis is of the greatest benefit. The usual sedatives can be given by mouth or rectum, and heart and respiratory stimulation reserved for the emergency.

SUMMARY OF THE AUTHOR'S CASES

The cases reported have been taken mostly from the records of the Alexian Brothers Hospital during the last eight years. In this connection I desire to thank my colleague, Dr. M. L. Harris, for the use of his material, and Dr. G. J. Noger, of the resident staff, for his assistance with the records.

There are in all fifteen cases.

Acute cases, 10; mortality, 90 per cent.

Chronic cases, 5; mortality, 20 per cent.

Total cases, 5; mortality, 55 per cent.

These numbers are too small to be of much value. The series includes cases treated medically, with antitoxin subcutaneously, with antitoxin intraneurally, and with spinal injections of magnesium sulphate. A tabulation appears on preceding page.

CASE 14. Jos. M., 8 years old. Admitted to the Alexian Brothers Hospital in the service of Dr. M. L. Harris, August 19, 1908.

History. August 12th was playing in back yard near stable, and stepped on a nail which penetrated his left foot at the base of the great toe. The wound received no medical attention. August 18th, six days after the accident, the first symptoms began in the shape of trismus, stiffness of the neck, and difficulty in swallowing. The next day, August 19th, he was brought to the hospital with tetanus well developed.

Examination. Well nourished boy; expression anxious and drawn; jaws could scarcely be opened; head retracted and neck stiff; no opisthotonos, but general rigidity ; lungs and heart negative; abdomen retracted and of boardlike hardness; exaggerated reflexes; no sensory disturbances; on sole of left foot at base of great toe is an innocent looking puncture almost healed; no inflammation or pus infection; leucocyte count, 21,000.

Treatment. Wound thoroughly opened and a small bit of stocking removed; cauterized with carbolic acid and alcohol; packed with gauze moistened with peroxide of hydrogen, and moist dressing applied; 1,500 units antitoxin given subcutaneously the evening of admission.

August 20. Fifteen hundred units under skin. Condition becoming worse. Some twitching of arms, but no general spasms. Opisthotonos developing; difficulty in swallowing.

August 21. All tetanic symptoms well marked; opisthotonos, general spasms, exaggerated reflexes, difficulty in swallowing and breathing. Abdomen hard; trismus marked; 8 A. M., 3 c. c. of a 25 per cent solution magnesium sulphate injected intraspinally. Ten A. M., general relaxation; knee jerks abolished; no more spasms; 3,000 units under skin. Five P. M., general condition bad; pulse more rapid; respirations shallow and slower; opisthotonos and trismus marked. Extremities and abdomen relaxed. Reflexes of lower extremities abolished. He remained relaxed and had no further convulsions or twitchings, but the pulse became weaker and the breathing more shallow and slow. There was no spasm of the respiratory muscles. He died the same night of heart failure, with muscles relaxed, all except neck and jaws. It may be that the heart failure was due to the paralyzing effect of the magnesium sulphate. The boy weighed about 60 pounds, and estimating the dosage at 1 c. c. for every 25 pounds body weight, would make the dose injected a trifle high.

CASE 15. Charley O'G. Age 13 years. Admitted to Alexian Brothers Hospital July 10, 1908, with a history of having fallen off of a back yard fence. Examination revealed a compound comminuted fracture of both bones of the right leg. The bones protruded through the stocking and the wound was very much soiled. The wound was cleaned up in the usual manner without the use of an anæsthetic, and temporary splints applied. During the first week the wound did nicely; there was no suppuration, but several small pieces of bone were discharged.

July 17. Seven days after injury, the boy first complained of stiffness of the neck and slight rigidity of the jaw; fifteen hundred units of antitetanic serum were injected subcutaneously. The sciatic nerve was exposed and 1,500 units injected directly into the nerve on the right side.

July 18. Becoming worse; jaws more rigid and head retracted; 3,000 units subcutaneously.

July 19. Tetanus well developed; opisthotonos; trismus; exaggerated reflexes; pains in back and legs; boardlike abdomen; difficulty in swallowing; 3,000 units subcutaneously; 6 c. c. of a 25 per cent solution of magnesium sulphate was injected subcutaneously. Lumbar puncture made, and three c. c. of a 25 per cent solution of magnesium sulphate injected at 9 P. M.

July 20. General condition better, and patient much more comfortable. Limbs relaxed, pains relieved and can open jaw somewhat and take nourishment; 3,000 units subcutaneously; towards evening the symptoms became worse again, and at 9 P. M., a lumbar puncture was made, 4 c. c. turbid fluid withdrawn, and 4 c. c. magnesium sulphate solution injected.

July 21. Within an hour after the last injection the muscles relaxed, and the patient slept and had a fair night. No convulsions; lower limbs somewhat anæsthetic; 3,000 units under skin.

July 22. Condition still fair, but spasm somewhat more severe than yesterday; 3,000 units under skin, and 6 c. c. magnesium sulphate subcutaneously.

July 23. Strong convulsions present again upon the slightest irritation; 9:30 A. M., 5 c. c. magnesium sulphate by lumbar puncture; 9:54 A. M., beginning muscular relaxation; 10 A. M., knee jerks absent; ankle

clonus and plantar reflex present; 10:30 A. M., all reflexes abolished; muscles relaxed; abdomen soft; pains gone; comfortable; 1,500 units under skin.

July 24. Patient somewhat rigid again, but no convulsions; reflexes returning; 1,500 units subcutaneously.

July 25. In extremely tetanic condition again in every way. Pulse very rapid and weak, and patient in extremis. He was so far gone that it seemed useless to give him another lumbar injection. A spinal injection of 5 c. c. magnesium sulphate was made, and for several hours afterwards death seemed imminent. The spinal injection was not the cause of the cardiac and respiratory collapse. After several hours there was relaxation and the boy responded to the heroic stimulation which was meantime being administered; 1,500 units subcutaneously.

July 26. Remarkable change for the better; says he feels all right; more completely relaxed than he has been for the last week. No convulsions nor exaggerated reflexes. Able to open jaws slightly; 6 c. c. magnesium sulphate and 1,500 units subcutaneously.

July 27. Condition remains good; 1,500 units under skin.

July 28. Not quite so good; slept little; slight spasms; 1,500 units.

July 29. Rigidity and spasms returned, but not so marked. Lumbar puncture and injection of 3 c. c. magnesium sulphate solution.

July 30. Slept better; taking lots of milk; choral and bromides by mouth; slightly rigid, but no spasms. Fairly comfortable; 1,500 units under skin.

July 31. Condition fair and symptoms gradually abating; 1,500 units.

August 1. Four c. c. magnesium sulphate by spinal injection was followed in an hour by complete relaxation which persisted until the next day; 1,500 units.

August 2. Condition improving; not at all urgent; reflexes present and but slightly exaggerated; 1,500 units.

August 3. As there were some slight spasms and increasing rigidity, a lumbar injection of 5 c. c. was made, and in an hour the reflexes were abolished.

August 5. Doing well generally, taking nourishment; sleeps fairly well; some spasms and rigidity coming on; a spinal injection of 4 c. c. magnesium sulphate was made with the usual good results; 1,500 units.

August 7. From this time on the improvement was steady. No more spinal injections were necessary. Sedatives were continued for some time and nourishment was taken freely. The wound, which had been reopened and redisinfected, had healed nicely and union of the bones was being established. He left the hospital, completely recovered, September 1, 1908.

CONCLUSIONS

1. Prophylactic injections of antitetanic serum in cases of suspicious wounds are unquestionably of great value in preventing the development of tetanus.

2. After the onset of the disease, the local treatment of the wound, aside from the usual antiseptic measures, should include the use of balsam of Peru, a remedy which has been shown to possess some antagonistic action on the tetanus toxin.

3. None of the many special methods of injecting the antitoxin has proven of value, and some of them are too dangerous for general use. Subcutaneous injections of serum in massive doses will yield equally good, if not better, results.

4. Spinal injections of magnesium sulphate solution, by eliminating the spasms, will tide many a patient on to recovery, who would die under any form of serum treatment alone. This form of treatment is destined to lower the death rate from tetanus more appreciably than anything which has been advanced heretofore, including the discovery of the specific serum. Great care should be exercised in arriving at the dosage.

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DIAPHRAGMATIC HERNIA

With Report of Three Cases

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DIAPHRAGMATIC hernias are not so rare as to be a curiosity, but are few enough to be of considerable interest. In reviewing the literature for 1908, not a single case could be found reported in American medical journals.

Von Bergmann's Surgery in regard to hernia of the diaphragm says, "up to the present time no radical operation has ever been performed for non-strangulated hernia in this region, although an operation is indicated provided the diagnosis is certain."

Diaphragmatic hernias are either congenital or acquired.

Congenital. The congenital hernia, as a rule, cannot be benefited by operation, because there is an absence of so much of the diaphragm that it is impossible to fill the opening. The diaphragm is derived from five elements — a mesial, two ventrolateral, and two dorsolateral formed much later. When the splanchnopleures meet so as to enclose the foregut, they form a mesial septum between the right and left halves of the cœlom, i. e., the gut has both a ventral and a dorsal mesentery. From this mesentery is developed the mesial element of the diaphragm. It is said that the vitelline veins which lie on either side of the foregut become so dilated that they push their covering of splanchnopleure out laterally until it comes in contact with and adheres to the somatopleure, thus forming the ventrolateral parts of the diaphragm. This occurs as early as the third week. The dorsolateral parts of the diaphragm are developed only in mammals and are apparently later structural additions, not occurring until the third month. They grow out as crescentic folds from the dorsum of the body, although the Wolffian ridge, the suprarenal body, and the development of the liver and stomach, all apparently aid in closing up the gap at the dorsal side of the diaphragm. The relatively large size and rapid development of the liver aid in separating the right pleural cavity from the peritoneal cavity, and explain why congenital hernias of the diaphragm occur on the left side so much oftener than on the right. Most authorities give a ratio of eight to one. When the diaphragm is fully developed there may be gaps between the muscular portions covered only by peritoneum and pleura. Two of these are constant, one ventrally between the sternal and costal portions known as the foramen Morgagni, and one dorsally between the lumbar and costal portions known as the foramen Bochdaleki. The congenital hernias are not true hernias in the sense that they have no peritoneal sacs.

Acquired hernias. The acquired hernias are more often amenable to surgical treatment. They may be acquired suddenly as following a stab or gunshot wound, a crushing injury, or from any cause which increases the intra-abdominal pressure, or they may be produced gradually by one of the abdominal organs forcing its way through a weak place in the diaphragm, or through one of the natural openings. The most frequent of the normal openings for the site of a hernia is the opening for the œsophagus. Next in frequency are the openings for the splanchnic nerves, and then the one for the aorta. Another form of hernia described by Thoma as *eventratio diaphragmatica*, is where the diaphragm is so relaxed that it simply bulges instead of rupturing.

Symptoms and diagnosis. The symptoms of diaphragmatic hernia are most commonly those of strangulation of some of the abdominal viscera. In order of frequency, the stomach, the large intestines, and the small intestines are quite commonly found in the thoracic cavity. If abdominal viscera have entered the thorax, their presence can be determined by an increased tympanitic note on percussion, and the sound of intestinal noises on auscultation. The lack of expansion of the lung, and symptoms

due to pressure upon the respiratory organs, should not be overlooked. Dextrocardia is a valuable sign, and in the absence of other causes for the heart being on the right side, a diaphragmatic hernia should be suspected. Distention of the stomach for the purpose of outlining it will be of service. A radiograph taken after a bismuth-paste meal, or a high enema containing bismuth, may show the stomach or colon, or both, in the thoracic cavity.

Non-strangulated hernias are much more difficult to diagnose. There is pain in the upper part of the abdomen and under the ribs, with colic. There may be persistent dyspepsia, acid eructations of gas and sour fluids, and persistent vomiting. Sometimes blood may be present in the vomitus and in the stools. There are cases in which the symptoms are more or less typical of gastric ulcer. (One of the cases reported in this paper was diagnosed as ulcer.) The stomach analysis may be misleading.

Treatment. There is no palliative treatment for this condition. Diet and rest may relieve the symptoms temporarily in some of the cases, but the great majority of them succumb to strangulation of some of the abdominal organs sooner or later. According to Lacher, of 36 cases of injury of the diaphragm that were not operated upon immediately, 5 died the first day, 10 within a month, 5 within five years, and 5 within twenty years, the result of strangulation. Berchthold collected 24 cases of injury of the diaphragm that had been operated upon, and found that 22 had recovered and only 2 had died.

There can be no definite method of operation for these cases, because no two are similar. Surgeons differ in regard to the method of approaching the hernia. Some advise doing a thoracotomy first, while others prefer the abdominal route. The chief arguments in favor of opening the thorax, are that in some cases it is impossible to reduce the hernia on account of the negative pressure above the diaphragm until the lung has been collapsed, and because the thoracic route gives easier access to the diaphragm for repair. The abdominal route, however, seems the more rational since a considerable number of hernias can be reduced without opening the thorax, and one does not care to collapse a lung if it can be avoided. The viscera injured from strangulation are the abdominal organs, which are better cared for through an abdominal incision. In certain cases, however, it is necessary to open both the abdominal and pleural cavities. In some cases the hernial opening can only be closed by suturing the stomach to the edges of the hernial ring.

The very large hernias are almost hopeless, and many of the smaller ones require all the skill and ingenuity of the experienced surgeon to effect a cure.

The following cases were operated upon by Dr. W. J. Mayo, at St. Mary's Hospital, and are reported with his permission.

CASE 1. C. E. S., aged 17 years. An American born boy; thin and undersized; weight 110 pounds. When a baby he would often wake up at night and vomit sour undigested food. The parents state that he had no trouble before he was three months old. Since then he has had constant stomach trouble, great distress, and at times vomiting of great quantities of soured, undigested food three or four hours after taking. When there was more fermentation than usual, the patient would be in bed for a few days. For the past year and a half he has used the stomach tube, often washing up remnants of food taken two days before. He now lives exclusively upon liquids. Bowels are constipated. The stomach is enormously dilated, and at times there is visible peristalsis. There are no breath sounds on the left side of the chest, and no expansion. The heart is in the median line and slightly to the right. Stomach analysis gave a total acidity of 48. Free HCl, 32. Combined HCl, 16. No lactic acid or blood. Diagnosis, *congenital diaphragmatic hernia and pyloric stenosis.*

Exploratory operation revealed a congenital absence of the diaphragm and of the lung on the left side. The duodenum, after passing behind the stomach, passed directly into the left chest. There were no intestines in the abdominal cavity except the sigmoid. The hugely dilated stomach filled the abdomen. No operative procedure was attempted.

CASE 2. J. N., aged 47 years. Farmer. Came for examination in December, 1906. A year previously he had a severe diarrhœa for three weeks, and dated the beginning of this trouble from that sickness. He passed no blood at this time and felt fairly well following the sickness, although food gave him some discomfort. For the past seven months he has had a great deal of distress after taking food, and has vomited a great deal of sour food from 15 minutes to one-half hour after eating. He has eructations of gas and sour liquids. Rich sweet foods disagree with him, but sour foods do not trouble him much. Bread and milk is his best diet. He has not been able to work much all

summer, and has lost sixteen pounds in weight. Bowels are fairly regular. Occasionally sour liquids are regurgitated at night, which gives him relief. He has a right inguinal hernia. He is thin, and his skin has a glossy appearance but not dry or cachectic. Stomach analysis showed total acidity of 9. No free HCl. Combined acidity, 5. Much blood and lactic acid. Diagnosis, *ulcer of the stomach*. The patient refused operation, but returned a year later. At this time he feels better than he did a year ago, and has not lost any more in weight. He is weak and has attacks of sour stomach and vomiting, the same as a year ago. He is constipated and has blood in the stools. Sour fluids regurgitate when stooping or lying down. There is a sore spot to the left of the pit of the stomach.

Operation. (1) Herniotomy. (2) Negative exploration of stomach and gall-bladder.— a diaphragmatic hernia to the left of the aorta nearly the capacity of the first, with a wide neck into which a portion of the stomach could easily pass. The stomach was sutured with mattress sutures of linen to the edges of the opening in the diaphragm and to the abdominal wall to prevent it from entering the hernial cavity. The patient made a good recovery and has been well since.

Case 3. Mrs. R. German; wife of a farmer: aged 47 years. Two children. Eight years ago she had some indefinite bladder trouble from which she recovered and remained well until four years ago when she was in bed four months with a cough, and pain in the region of the stomach. She gradually began to have attacks of sharp, severe pain in the pit of the stomach and to the left side, one-half hour after meals. She began to vomit when the stomach was full, not vomiting, as a rule, after a single meal unless she ate a great deal. She occasionally vomited dark blood, and food eaten two or three days previously. At night would vomit food eaten at noon. During the last year she has had more severe pain and vomits more; has not been able to keep food in the stomach more than an hour. About a year ago she noticed a tumor the size of a hen's egg under the right costal arch, which she could move about freely. It increased in size. She lost 100 pounds in three years, and was very much emaciated. The heart beat was intermittent; apex beat to the right on a level with the end of the sternum. There was a small freely movable tumor the size of a lemon under the right costal arch which was not very tender. No enlarged glands could be felt. Stomach analysis: total acidity 5. No free HCl. Combined acids, 2. Lactic acid present. No blood. At the time of the stomach examination the tube could not be passed but a short distance, and on attempting to distend the stomach the patient experienced so much pain that the effort was abandoned. Diagnosis, *cystic gall-bladder*. Stomach to be explored.

Operation. Diaphragmatic hernia in which one could introduce the hand at the site of the œsophagus. On opening the abdomen no stomach was to be found. The duodenum on the left side was traced up to the pylorus which lay high up under the left lobe of the liver just at the diaphragmatic opening. The entire stomach, which was very large, was in the thoracic cavity, and quite adherent inside the cavity next to the heart, but outside the pericardium. Adhesions were loosened up and tied extensively which, fortunately, could be done, as the patient was very much emaciated. The stomach was sutured by mattress sutures of linen, the dome to the margins of the diaphragmatic opening, the body sutured at various points to the parietal peritoneum, and the pylorus and duodenum were drawn to the right side and held by sutures so that the entire stomach was replaced. Large cystic gall-bladder containing one stone. Cholecystectomy.

The patient did not vomit while in the hospital, and made an uneventful recovery.

THE SUBMUCOUS LIPOMA OF THE GASTRO-INTESTINAL TRACT

A Report of Two Successfully Operated Cases and an Analysis of the Literature

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THE so-called benign neoplasms of the stomach and intestines are generally regarded as playing a most insignificant role in the surgery of the abdominal cavity and little stress is laid upon their importance either in text-book or monograph. It has been the writer's good fortune to have observed and treated an interesting case belonging to this group and to have had another one placed at his disposal for publication. These two cases have called his attention to at least one form of the non-malignant tumors, namely, the submucous lipoma, and they have inspired him to make a thorough search of the literature of that particular lesion. He has been surprised at its comparative frequency and astonished at the really grave complications to which it can give rise. In view of the fact that the surgical literature contains little that is at all authoritative upon this subject and

in the hope that some light may be thrown upon the diagnostic and therapeutic possibilities of the condition, the author has been led to publish the results of his investigations.

The following is a report of the author's personal observation:

1. Large, lobulated, polypoid, submucous lipoma of the ileum producing a chronic ileocæcal intussusception and intermittently protruding at the anus. Laparotomy. Maunsell resection and anastomosis. Recovery.[1]

Mrs. M. W., age 36, married, admitted to the first surgical service of the German Hospital, January 28, 1909, with the diagnosis of rectal prolapse. Her family history is unimportant. She has two children alive and well, and had one miscarriage at five months. Three years ago she had two very severe attacks of abdominal pain lasting a short time and not repeated since. She does not remember if vomiting, distention, or fever were associated with these attacks, or just where the pain was localized.

She states that since two years ago she has had trouble with her rectum. At that time a mass the size of a fist suddenly prolapsed at the anus after the patient had taken a strong cathartic. This was replaced with difficulty by a physician, and for one year there was no prolapse, the patient simply suffering from constipation. One year ago, following a fright, there was a second prolapse, considerably larger than the first. This was again replaced by her doctor, the knee-chest position being resorted to. From this time on there were frequent partial protrusions, particularly of late. The frequency varies from once in several days to two or three times daily. The bowel only prolapses during stool or when there is a desire for defecation, but the patient is able to hold it back partly by drawing in and guarding the anus with her hand when she feels it coming. The prolapse does not occur with every evacuation, especially if the fæces are formed. Indigestible food, particularly anything causing loose movements, tends to produce it, and it appears that any nervous shock has the like effect.

She has no real pain, but for about one-half hour preceding the prolapse she has cramp-like sensations throughout her abdomen, which, prior to the extrusion, become most severe, and are localized in the left iliac region. In the past week there has been a dull ache in this region, independent of the prolapse. The patient also has the feeling of something rolling around in her abdomen, which resembles greatly the quickening of pregnancy. She is troubled considerably with flatulence and gurgling sounds in the intestines. She never vomits directly previous to, during, or after the prolapse, though she does suffer from migraine attacks and vomiting every few weeks. She has had no erection of the gut. Her bowels are constipated, but move well with cathartics, and the stools contain neither blood, mucus, nor pus. There are no urinary symptoms, and menstruation is normal. There has been no loss of weight and the appetite is good. Her chief complaint is the prolapse of the rectum, so that she has a constant dread of going to stool.

Status præsens. The patient is a well developed, healthy looking woman with a moderate panniculus. Her head and thorax show no abnormalities.

There is no abdominal tenderness, rigidity, or distention. There is no ascites. The right kidney and spleen are easily palpable. The left kidney cannot be felt. Above the umbilicus and somewhat to the left is felt an elongated, soft, movable mass which descends on inspiration. This mass is not sensitive, is of rather diffuse and indefinite outline, and measures approximately 12 x 6 centimeters. The anal orifice is very relaxed, easily admitting two fingers without pain. The lower rectum forms a large pouch, and the mucous membrane of the anterior wall is redundant, but there is no prolapse, even when the patient strains.

After the patient had been given a dose of castor oil and an enema, and while she was straining at stool, a polypoid tumor prolapsed, which was first the size of a hen's egg, but which rapidly increased to that of two fists. The prolapse consists of a soft, lobulated, non-sensitive mass, covered with a smooth mucous membrane, and showing posteriorly and above a longitudinal striation and sacculations, which seem to be the tænia and haustræ of the large intestine. No lumen can be detected and on inserting the finger around the mass into the anus, a distinct pedicle of the thickness of two fingers can be felt, which can be followed to the promontory of the sacrum, but of which the end cannot be reached. The walls of the rectum have not changed their relative positions. The patient complains of no particular pain while the mass is extruded. It might here be noted that the tumor showed one peculiarity, which, at the time of the examination, was not given due consideration, namely, that the reddish mucous membrane presented a distinct yellowish tinge.

With some difficulty the mass was reduced with the patient in the knee-chest position. Abdominal examination immediately after reduction shows that the soft indefinite mass which was previously felt in the left hypochondrium has shifted to the left paraumbilical region.

Vaginal examination reveals nothing of special significance.

The urine and stool examination is negative.

A presumptive diagnosis of polyp of the descending colon or sigmoid with secondary inversion of the intestinal wall was made and a laporotomy was decided upon. This was performed by the writer on January 30, 1909.

Operation. Under anæsthol anæsthesia a small incision was made at the outer border of the left rectus and the sigmoid and descending colon were examined. They were found decidedly dilated, but strange to say, empty and otherwise normal. The incision was elongated upwards, and the transverse colon brought into the wound. This was carefully palpated, and here, to be sure, could be felt a soft mass in the lumen of the gut reaching down almost to the splenic flexure.

[1] Patient presented at the Surgical Section of the New York Academy of Medicine, March 5, 1909.

Following the mass upwards it was at once apparent that an ileocæcal invagination existed to the apex of which was attached a soft polypoid tumor.

A gentle disinvagination was attempted and was partially successful. A reduction of some 20 centimeters of the inner small and outer large intestine, including the appendix, was accomplished, but then all efforts of traction on the small gut or pressure on the invaginated portion failed to further reduce the intussusception owing to adhesions between its two leaves. By this time the apex of the intussuscepted mass reached about the hepatic flexure. When it was noted that the serosa of the ileum was beginning to tear at the entrance of the invagination, it was decided to resect the intussusception, according to Maunsell's method. First the ileocolic junction, which was quite mobile, owing to a distinct mesentery for the ascending colon, was drawn well out of the abdominal wound, the peritoneal cavity was carefully tamponed off, the appendix was removed, and the stump inverted. Clamps were then applied to the ileum and transverse colon and the ascending colon was incised longitudinally through its anterior tænia. Through this incision the invaginated mass was delivered. This was resected at its base beyond the adherent area, hæmorrhage was carefully controlled and the two lumina of gut were united first with four interrupted and then with a running silk suture through all their coats, serosa against serosa. The colon incision was closed with a double row of Lembert sutures of silk, and the anastomosis was reinforced by another continuous peritoneal suture of the same material.

A small hæmatoma in the mesentery of the small intestine for a few moments marred the smoothness of the operation, but this was promptly controlled by pressure. An inch and a half drainage opening was made through the right rectus sheath. Two gauze tampons were inserted to safeguard against a possible leakage, and the left-sided incision was closed completely in three layers. The time of the operation was one hour and twenty-five minutes, and the patient left the table in very good condition.

Aside from a moderate paralytic ileus, with distention, hiccough, and occasional biliary vomiting on the third and fourth day after operation, which yielded quickly to lavage and rectal irrigation, the patient made an uneventful, afebrile recovery. Her highest rectal temperature was 100.8° F., and her most rapid pulse rate was 112 per minute.

On the fourth day the tampons were changed and gas and stool were passed on the same day. The silkworm gut sutures were removed on the eleventh day. The left wound healed primarily, and there was no fæcal leakage through the drainage wound. The drains were discontinued after two weeks, the patient was up on the eighteenth day and left the hospital cured three weeks after the operation. The small granulating wound on the right side was closed completely within another two weeks. The patient was last seen on April 2, 1909. The scars were firm; there was no hernia, and she was entirely free from her former symptoms.

Examination of the specimen shows that the intestine has been resected some 4.5 to 5 centimeters from the tip of the invagination, so that just twice that length of gut was removed. The intestine proves to be ileum probably directly above the ileocolic junction. The two leaves of the invagination are adherent and are separated with difficulty. Even after separation of the two layers reduction of the invaginated gut is impossible owing to the size of the tumor, which is situated directly at the apex of the invagination and attached to the intestine by a broad pedicle involving almost one-half its circumference, of which the mid-point corresponds about to the mesenteric attachment. It is a large, soft lobulated, polypoid, mucous membrane covered growth, the size of a man's fist, and actually measuring 10 x 8½ x 4½ centimeters with a maximum circumference of 16 centimeters. Its weight is 160 grams. Incising the mucous membrane one enters pure fat tissue lying between the mucosa and the muscular coat. Figure 1 is an accurate reproduction of the specimen.

Microscopical examination shows that the fat is situated just beneath an atrophic mucosa and in places an apparently hypertrophic muscularis mucosæ, in a network of connective tissue and blood-vessels (Figure 2). The lymph follicles are very much atrophied. Besides the mucous membrane there is a fairly definite fibrous capsule to the tumor which sends trabeculæ into the parenchyma. The hypertrophy of the muscularis mucosæ is partly real and partly apparent, due to the atrophy of the mucosa.

This study of the specimen cleared up the diagnosis. A submucous lipoma of the ileum had produced a chronic ileocæcal intussusception. It must be assumed that after a time the tumor had grown so large within the colon that complete, spontaneous reduction was no longer possible, and that for some 5 centimeters from its apex, the invagination became fixed, due to adhesions between its two layers. Intermittently at stool, the tumor simply dragged the ileum through the inverted colon, and prolapsed with more or less intestine at the anus.

Figure 3 shows semi-diagrammatically the condition found at operation. Particularly does the author desire to call attention to the position of the tumor in relation to the lumen of the gut. The intestinal opening was quite covered by the tumor as it lay in the colon as was also the case when it prolapsed at the anus. For this reason the definite diagnosis of a characteristic invagination was not made.

Through the courtesy of Dr. Willy Meyer of the German Hospital, a second operated case of submucous lipoma of the intestine has been placed at the writer's disposal. Though this

Fig. 1. Polypoid submucous lipoma of ileum and resected apex of invagination. Case I. Actual size. Intestine viewed from free border and tumor seen from posterior aspect to show lumen of gut and two adherent leaves of intussusception. Mucous membrane of one lobe incised to show fatty tissue.

case has been very briefly referred to elsewhere in a previous publication, the details, which follow, appear now for the first time:

2. Sessile, submucous lipoma of the transverse colon. Chronic history with exacerbations. Laparotomy. Resection. End-to-end anastomosis. Recovery.

Miss N. S., age 20, unmarried, admitted to the surgical service of the German Hospital May 6, 1901. Her family and previous personal history are unimportant.

For three months the patient has had attacks of epigastric pain, mostly to the left of the median line, colicky in character, and radiating downwards. Accompanying the pain are sensations of cold, headache and vomiting, and during the attack the abdomen is sensitive. The attacks last about four hours, occur twice a week, and usually develop during the afternoon at the same time after the noonday meal. In the intervals the patient is comparatively well, but she always has some pain. The bowels are regular, and there is no blood or mucus in the stools. The urine is diminished during the attack and increased afterward. Menstruation is painful but otherwise normal. The patient has not lost weight.

Status præsens. The patient is well nourished. Her abdomen is soft and concave. In the upper part of the abdomen near the median line, is a hard, slightly sensitive mass, about the size of a hen's egg, which moves on respiration and is extremely mobile. It can be moved in all directions, but particularly to the left. The tumor disappears on inflation of the colon.

Vaginal and rectal examination is negative.

The urine and stools are normal.

A diagnosis of tumor of the transverse colon, presumably sarcoma, was made and a laparotomy performed.

Operation May 22d, 1901, by Dr. Meyer. Under anæsthol anæsthesia, a median incision above the umbilicus was made and near the splenic flexure of the transverse colon was felt a rounded intraintestinal tumor attached to the mesocolic angle. As the attachment seemed sessile and sarcoma was suspected, a resection of 8 to 10 centimeters of gut was performed and the intestine united by end-to-end suture. The abdomen was closed by through-and-through silk sutures.

The patient made a prompt, uninterrupted recovery. She passed gas on the fourth day, her bowels moved on the eighth day, and she left the hospital cured six weeks after operation. She is to-day in good health.

Examination of the specimen (Figure 4) shows it to be a sessile, submucous lipoma, the size and shape of a large walnut. It is attached at the mesenteric border.

Microscopical examination confirms this diagnosis. It shows the adipose tissue directly under the mucous membrane. It is imbedded in a connective tissue and vascular stroma. The superficial layer of the mucosa is ulcerated and necrotic in spots, with inflammatory

Fig. 2. Photomicrograph from Case I. Fatty tissue in connective tissue and vascular stroma beneath atrophic mucosa and apparently hypertrophic muscularis mucosæ. Fibrous capsule sending trabeculæ into parenchyma and atrophic lymph follicle. Medium power.

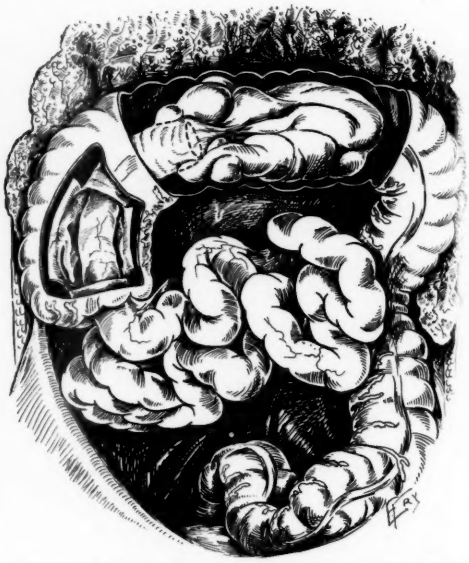

Fig. 3. Semi-diagrammatic sketch of condition found at operation in Case I. Window cut out of transverse colon shows tumor at apex of invagination covering lumen of gut (indicated by dotted line) and reaching to splenic flexure. Window cut out of ascending colon and longitudinal slit in outer leaf of intussusception shows invaginated cæcum and appendix.

Fig. 4. Sessile submucous lipoma of transverse colon. Two-thirds size. Case II.

Fig. 5. Photomicrograph from Case II. Fatty tissue in connective tissue and vascular stroma beneath mucosa. Necrotic and ulcerated superficial layer of mucosa with inflammatory infiltration of deeper strata (to left). To right, almost adenomatous hypertrophy of glandular elements and excessive filling of goblet cells (mucous colitis). Low power.

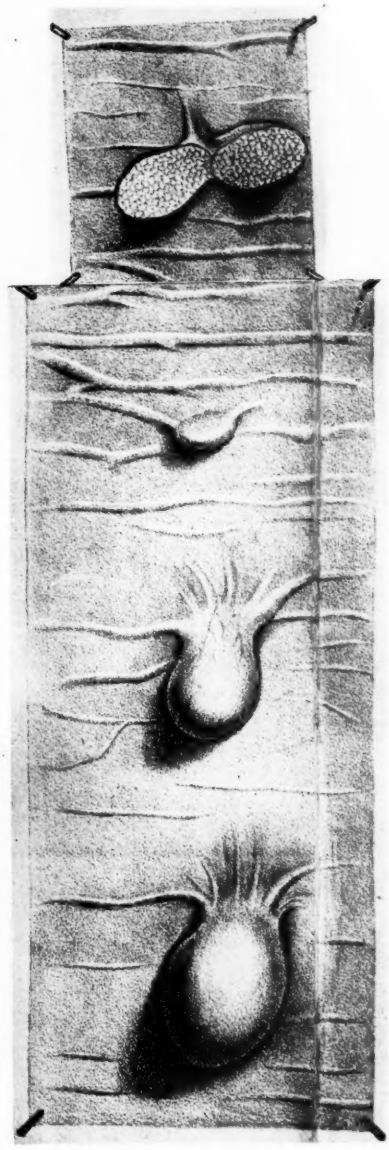

Fig. 6. Huss's case of multiple polypoid submucous lipomata of ileum. Cut above shows one specimen incised. Actual size.

infiltration of the deeper strata. In other places there is an almost adenomatous hypertrophy of the glandular elements and an excessive filling of the secreting goblet cells, the characteristic changes of a mucous colitis. (Figure 5.)

A careful examination of the literature of lipoma of the gastro-intestinal tract brought forth some interesting facts. Only in recent years has any particular attention been paid to the matter at all, although the older pathologists seem to have been cognizant of its existence. Hiller with twenty-two cases, and Kozielski in 1899, Ward in 1904 with thirty-five cases, Dewis with forty-four and Hellström with forty-five cases in 1906, are the only authors who have made any attempt to offer collective statistics. As the opinions of these writers vary considerably, as none of them gives us more than a very incomplete review, and as all include under the same category two entirely different growths, the submucous and the subserous, the author has undertaken to present an accurate compilation of all hitherto reported cases of the former variety, consulting the original articles in every instance where available and reproducing all existing illustrations. He has limited himself strictly to the submucous or internal lipomata of the stomach and intestine. It might be mentioned in passing that analogous tumors may form in any part of the mouth, pharynx, or œsophagus, giving rise to disturbances of phonation, respiration, or deglutition, but it would take us too far to consider all the varieties, and only the submucous fatty tumors of the alimentary canal below the diaphragm will be dealt with.

It might also be noted that subserous lipomata of the intestine, usually arising from appendices epiploïcæ or from the adipose tissue of the mesentery are not uncommon. These grow outward into the peritoneal cavity, often develop into large, generally pedunculated growths and may cause very critical disturbances either by the size of the tumor, by simple pressure on the intestine or other important organs, or by kinking, twisting, stenosing or strangulating the gut either directly or through the action of their pedicle. Sometimes they separate from the intestine and become so-called free bodies in the abdominal cavity, which frequently calcify. This whole question, however, is beyond the scope of this paper.

The following is a table of cases of submucous lipomata of the stomach and intestines chronologically arranged to date:

TABLE OF CASES*

Number of Case	Author Date	Sex Age	Location	Number, Size, Shape	Duration, Symptoms, Complications	Treatment	Result Remarks
1.	Bauer, 1757.	Male.	Possibly colon.	Multiple, possibly some adenomata.	Pain and obstructive symptoms for 7 weeks.		Passed spontaneously. Recovery.
2.	Meckel, 1818.		Duodenum.		No symptoms.		Post-mortem find.
3.	Meckel, 1818.	Female.	Colon.		No symptoms.		Post-mortem find.
4.	Meckel, 1818.		Colon.		Invagination.		Specimen.
5.	Huss, 1844.	Male, 44.	Ileum.	Twelve polypoid, bean to hazelnut.	No symptoms from tumor. Diarrhœa, tenesmus, and blood from ulcers.		Post-mortem find. Concomitant entero-colitis. Figure 6.
6.	Huss, 1844.		Sigmoid.	"Good example."	Apparently no symptoms.		Post-mortem find.
7.	Cruveilhier, 1856.		Apparently intestine.	Large pea.	No symptoms.		Post-mortem find.
8.	Sangalli, 1860.		Colon descendens.	Two. Larger, hen's egg.	Invagination and prolapse from larger tumor.		Specimen.
9.	Virchow, 1863.		Stomach near pylorus.	Hazelnut. Sessile.	No symptoms.		Post-mortem find. Figure 7.
10.	Virchow, 1863.		Jejunum.	Olive. Polypoid. Pedicle.	No symptoms.		Post-mortem find. Figure 8.
11.	Castelain, 1870.	Male, 43.	Probably colon.	12 x 6 cm.; 2 to 3 cm. pedicle. Lobulated.	4 weeks, nausea, pain, constipation and tenesmus, mucus and blood in stools.		Passed spontaneously. Recovery.
12.	Ninaus, 1871.	Male, 32.	Ileum.	Dollar. Polypoid.	Months; colic in ileo-cæcal region. Acute obstruction which partially subsided. After 26 days 120 cm. invagination expelled.	Palliative.	Passed spontaneously with invaginated gut. Recovery.
13.	Hoyt, 1872.	Female, 55.	Probably colon.	Child's head. Pyriform; 4 ounces; 5½ x 3½ in. 2½ x ½ in. pedicle. Cystic degeneration. Ulcerated.	Constipation and diarrhœa. Prolapse. Tumor per rectum.	Removal from anus. Prolapse reduced.	Death.
14.	Afezou (Bernard), 1875	Female, 83.	Rectum.	Pigeon egg. 20 gm. Polypoid. Pedicle.	Years. Colic, diarrhœa and constipation.		Passed spontaneously. Recovery.
15.	Morel, 1876.	Female, 36.	Small intestine.	Large.	5 years. Pains like labor pains. Flatulence.		Passed spontaneously. Recovery.
16.	Coupland, 1879.	Female, 16.	Ileum.	Little finger. Polypoid.	2d attack of acute obstruction. Abdominal tumor. Acute ileo-cæcal invagination.	Enterostomy.	Death.
17.	Voss, 1880.	Female, 47.	Sigmoid.	Goose egg. Pedicle.	Tumor per rectum. Invagination.	Removal from anus. Invagination reduced.	Recovery.
18.	Albrecht, 1880.	Male, 51.	Colon.	11 x 6 cm. Pyriform 3 cm. Ped. quill thick.	6 weeks. Pain especially after meals, diarrhœa, tenesmus, mucus and blood in stools. Loss of weight.		Passed spontaneously. Recovery. Patient obese. Lipoma of right thigh.
19.	Esmarch (Weiss) 1882.		Sigmoid.	Plum. Pedicle.	4 in. prolapse of rectum. Tumor at rectum.	Removal from anus. Prolapse reduced.	Recovery.
20.	Esmarch (Bose) 1882.		Sigmoid.	Polypoid.	Prolapse of rectum. Tumor per rectum.	Removal from anus.	Recovery.
21.	Tuffier, 1882.	Female, 43.	Lower sigmoid.	Orange. Pyriform. Pedicle.	9 mos. constipation. 4 mos. pain in left groin. Tumor per rectum. Acute invagination.	Colostomy.	Death. Patient obese.
22.	Turner, 1884.		Small intestine.	Cherry. Polypoid.	Invagination.		Museum specimen.
23.	Wallis, 1884.	Female, old.	Entire colon.	Multiple. 1–2 cm.	No symptoms.		Post-mortem find.

*Certain cases quoted by some authors have been omitted as not belonging to our group.
The case of Van Vaernewyck and one of Tédenat's are retro-rectal lipomata. Wells' case is a lipoma of the recto-vaginal septum. The cases of Worthington, Nolan, Malapert, Goyanes and Chandler and Baldauf are subserous growths. Broca's case is an adenomatous rectal polyp, the removal of which from below resulted fatally due to a perforation of the gut. Hodgkins's stomach case is probably an accessory pancreas

TABLE OF CASES (*Continued*)

Number of Case	Author Date	Sex Age	Location	Number, Size, Shape	Duration, Symptoms, Complications	Treatment	Result Remarks
24.	Tédenat, 1885.	Female, 64.	Rectum.	13 x 6 cm.; 3 to 4 cm. pedicle, fore-finger thick. Ulcerated.	6 years. Digestive disturbance, constipation, diarrhœa; blood and mucus in stools.	Removal from anus.	Recovery.
25.	La Garde, 1886.	Male, 65.	Upper rectum.	2½x1½ in. 12 drams. 8 in. pedicle, little finger thick.	3 years. Mucus and blood in stools. Constipation. Tumor per rectum.	Removal from anus.	Recovery.
26.	Lewtas, 1888.	Male, 45.	Possibly duodenum.	1½ x 1½ x ½ inches. "Lymphoma."(?)	Acute pain like biliary colic.		Passed spontaneously. Recovery.
27.	Link, 1890.	Male, 45.	Colon descendens.	Fist. Ovoid, thick pedicle from mucosa.	5 years. Constipation and abdominal tumor. Prolapse of and tumor per rectum. Hæmorrhage. Invag.	Removal from anus. Invagination reduced.	Recovery.
28.	Hofmokl, 1892.	Female, 39.	Colon ascendens.	Polypoid.	Chronic invagination.	Laparotomy. Resection.	Death.
29.	Richardson, 1892.	Male, 52.	Cæcum, 1 inch from valve	Pear. Broad pedicle.	40 years ago, colic with prolapse of and tumor at rectum. Acute ileo-cæcal invagination to sigmoid.	Laparotomy. Disinvagination. Removal of tumor.	Death.
30.	Stabb, 1894.	Male, 32.	Ileum, 30 inches from cæcum.	3 acorns. Lobulated Polypoid; ulcerated. Opposite mesentery.	Acute ileo-ileal invagination. Abdominal tumor.	Laparatomy. Disinvagination. Removal of tumor. Secondary resection for hæmorrhage and fæcal fistula.	Death. Figure 9.
31.	Stabb, 1894.		Ileum.	Almond. Pedicle.	Apparently no symptoms.		Museum specimen.
32.	Studsgaard, 1894.	Female, 42.	Jejunum.	Walnut. Polypoid.	Acute invagination, 128 cm.	Laparotomy. Resection.	Death.
33.	Marchand, 1896.	Male, 23.	Lower ileum.	Fist, also subserous.	5 days. Acute ileo-cæcal invagination	Enterostomy.	Death.
34.	Nattan-Larrier and Roux, 1897.	Female.	Duodenum, posterior wall 8 cm. from pylorus.	6 x 3 cm. Pedicle.	No symptoms. Stomach dilated.		Post-mortem find.
35.	Bodenhamer, 1898.	Male, 37. Negro.	Rectum.	Hen's egg. Pedicle.	16 years. Tumor of anus.	Removal from anus.	Recovery.
36.	Bierring, 1898	Female, 23.	Possibly colon.	Multiple. Polypoid. 1 to 4 x ½ to ¾ in.	Years. Pain and constipation. Tumors passed for 6 months.		Passed spontaneously. Recovery. Figure 10.
37.	Hiller (Steinthal), 1899.	Male, 51.	Lower ileum.	Walnut. Sessile, 2 cm. from mesentery.	Acute ileo-ileal invagination; 50 cm.	Laparotomy. Resection.	Death.
38.	Russell(St.Thomas's Hospital Reports) 1899.	Male, 56.	Sigmoid.	Small orange. 1½ in. pedicle.	2d attack of acute obstruction; 1st 23 yrs. ago. Abdominal tumor. Blood in rectum.	Laparotomy. Removal of tumor.	Recovery.
39.	Kozielski, 1899.	Male, 68.	Duodenum.	Plum. 4.5 x 3.8 x 2 cm. Pedicle.	No symptoms.		Post-mortem find.
40.	Kozielski, 1899.	Female, 29.	Duodenum.	Bean, 1.5 x 1 x 1.5 cm. Sessile.	No symptoms.		Post-mortem find.
41.	Knaggs, 1900.	Female, 29.	Ileum.	Hen's egg. Pedicle thumb thick. Ulcerated.	5 wks., diarrhœa, vomiting, pain, increasing in severity. Tarry stools. Abdominal tumor. Acute ileo-ileal invagination.	Laparotomy. Disinvagination. Removal of tumor.	Recovery.
42.	Heurtaux, 1900.	Female, 60.	Colon descendens.	Small apple. 5.7 x 4.8 cm. Polypoid.	Subacute invagination. Tumor per rectum.	Removal from anus. Invagination reduced.	Recovery.
43.	Bland-Sutton, 1900.	Male, 44.	Colon ascendens, 5 cm. below valve.	60 gm. Pedicle. Lobulated.	7 years. Pain like appendicitis. Abdominal tumor. Feeling of something moving in abdomen. 2d attack of acute obstruction.	Laparotomy. Removal of tumor.	Recovery.

under the mucosa, near the pylorus. The museum specimen spoken of by Treves seems to be identical with Turner's case, and Clos's and Tuffier's cases are the same. Hellström, though speaking of eleven cases, only reports ten.

It has been impossible to locate a case supposed to have been reported by F. C. Holst and referred to by Voss, and one of Fischer quoted by Clos. Paci, who, according to various writers, is credited with a case, clearly has never seen the condition.

TABLE OF CASES (*Continued*)

Number of Case	Author Date	Sex Age	Location	Number, Size, Shape	Duration, Symptoms, Complications	Treatment	Result Remarks
44.	Hahn, 1900.	Male, 43.	Upper ileum.	4 polypoid. Hazelnut to 5 cm. Also 1 subserous.	½ to ¾ years. Constipation alternating with diarrhœa. Acute ileo-ileal invagination.	Laparotomy. Disinvagination. Resection.	Recovery.
45.	Michaux, 1900.	Female, 56.	Colon descendens.	7 x 8 cm. Polypoid. 1.5 cm. pedicle.	Acute invagination into sigmoid. Abdominal tumor.	Colostomy.	Death.
46.	Gross, 1900.	Male, 47.	Colon transversum, left.	Egg. Long pedicle towards mesentery. Apex gangrenous.	14 days. Cramps. Variable abdominal tumor.	Laparotomy. Removal of tumor.	Recovery. Would have been passed spontaneously.
47.	Langemak, 1900.	Female, 57.	Cæcum, 2 cm.	Walnut.	9 years. Cramps, 3 to 4 wks., diarrhœa. Chronic ileo-cæcal invagination to splenic flexure.	Laparotomy. Disinvagination. Resection.	Recovery.
48.	Langemak, 1900.	Male, 55.	Jejunum.	Hazelnut. Polypoid.	No symptoms.	Removal at jejunostomy for cancer of stomach.	Recovery.
49.	Hemmeter (Welch) 1901.		Colon.	Hazelnut. Sessile.	Apparently no symptoms.		Museum specimen. Figure 11.
50.	Fuchsig, 1901.	Male, 47.	Ileum, 50 cm. from valve.	Walnut. Sessile. Surface necrotic.	Several years; pain and diarrhœa. 4 days acute ileo-ileal invagination.	Laparotomy. Disinvagination. Removal of tumor.	Recovery.
51.	Gant, 1902.		Rectum, left lateral wall 4 inches above anus.	Walnut. Polypoid. 1 in. pedicle.	Tumor per rectum.	Apparently removal from anus.	Apparently recovery.
52.	Tuttle, 1902.		Rectum, anterior wall 4 in. above anus.	Polypoid.	Tumor per rectum.	Apparently removal from anus.	Apparently recovery.
53.	Tuttle, 1902.		Rectum, posterior wall.	Hen's egg. Lobulated.	Tumor per rectum.	Removal from anus.	Recovery.
54.	Mouchet, 1902.	Male, 68.	Lower third of ileum.	Hen's egg. 11 cm. circumference. 30 gm. Pedicle to mesenteric border.	Years. Constipation and chronic obstruction. Acute ileo-ileal invagination.	Laparotomy. Disinvagination. Removal of tumor. Secondary colostomy.	Death.
55.	O'Conor, 1903.	Female, 45.	Cæcum.	Small orange. Mucosa gangrenous.	Indigestion, pain, constipation. loss of weight. Abdominal tumor.	Laparotomy. Removal o. tumor.	Recovery.
56.	Zum Busch, 1903.	Male, 21.	Apex of Meckel's diverticulum.		Acute ileo-cæcal invagination.	Laparotomy. Resection.	Recovery.
57.	Ward, 1904.	Male, 37.	Duodenum (?).	4 to 5 inches.	2 months; gastric pain, biliary colic, vomiting, blood and mucus in stools; loss of weight.		Passed spontaneously. Recovery.
58.	Ward (Macdonald) 1904.	Female, 50.	Jejunum.	2½ x 1¼ in. Pyriform.	6 mos.; pain, loss of weight; chronic jejunal invagination.	Laparotomy. Resection.	Recovery.
59.	Ward (Macdonald) 1904.	Female, 29.	Cæcum.	8 x 5 x 3 cm. Sessile.	1 year; colic, constipation, resembling appendicitis. Abdominal tumor.	Laparotomy. Removal of tumor.	Recovery.
60.	Ray, 1905.	Female, 30.	Sigmoid.	Called subserous by mistake. 2¾ x 2¼ x 9 in. 2 ounces, 5½ drams. Ovoid. Polypoid; mesocolic angle.	Acute invagination, 12 in. Tumor per rectum.	Laparotomy. Disinvagination. Removal of tumor.	Recovery.
61.	Fischer, 1905.	Female, 37.	Stomach, lesser curvature.	Walnut. Sessile. Hæmorrhage. Local peritonitis. Fibrolipoma, subserous (?).	5 wks. Symptoms of gastric ulcer. Pain especially 3 days.	Laparotomy Excision of tumor.	Tetany. Recovery. Also epigastric hernia.
62.	Hellström, 1906.	Male, 77.	Stomach 7 to 8 cm. from pylorus.	Hazelnut. Sessile.	No symptoms.		Post-mortem find.
63.	Hellström, 1906.	Male, 52.	Duodenum.	Club-shaped. 4 cm.	No symptoms.		Post-mortem find.
64.	Hellström, 1906.	Female, 87.	Duodenum.	Pea. Sessile.	No symptoms.		Post-mortem find.
65.	Hellström, 1906.	Male, 50.	Jejunum.	Bean. Sessile.	No symptoms.		Post-mortem find.

TABLE OF CASES (*Continued*)

Number of Case	Author Date	Sex Age	Location	Number, Size, Shape	Duration, Symptoms, Complications	Treatment	Result Remarks
66.	Hellström, 1906.	Male, 73.	Ileum.	Nut. Irregular. Lobulated, Pedicle.	No symptoms.		Post-mortem find.
67.	Hellström, 1906.	Male, 68.	Ileum.	Hazelnut. Pedicle.	No symptoms.		Post-mortem find.
68.	Hellström, 1906.	Male.	Ileum.	Multiple. Bean. At mesenteric border. Some subserous.	No symptoms.		Post-mortem find.
69.	Hellström, 1906.	Male, 47.	Colon transversum.	Apple. Sessile. Superficial ulceration.	2 years ago colic and distention; 2 wks. epigastric pain for 4-5 hrs. especially after indigestible food. Constipation. Distention. Feeling of something in abdomen. Abdominal tumor	Laparotomy. Resection.	Recovery.
70.	Hellström, 1906.	Female, 16.	Colon.	Fibrolipoma. Apple; necrot. conn. tissue covering.			Passed spontaneously. Recovery.
71.	Hellström, 1906.	Male, 47.	Colon.	Apple; 1 cm. pedicle, thread thick. Sclerotic capsule.	7 to 8yrs.; pain, constipation, diarrhœa. 1 month acuter symptoms. Abdominal tumor		Passed spontaneously. Recovery.
72.	Knowlton, 1906.	Female, 56.	Cæcum and ascending colon.	Quill-sized stenosis. Diffuse fibrolipoma.	20 yrs. Chronic obstruction, emaciation Abdominal tumor.	4 laparotomies. Final resection.	Recovery.
73.	Boas, 1907.	Male, 55.	Apparently intestine.	Polypoid. Pedicle.	4 mos., attacks of pain, then more acute symptoms and feeling of something loosening in abdomen.	Karlsbad cure.	Passed spontaneously. Recovery.
74.	Hochenegg, 1909.		Cæcum.	Small egg. Polypoid. Ulcerated.	Chronic invagination. Abdominal tumor.	Resection.	Recovery. Figure 12.
75.	Klein, 1909.	Female, 40.	Colon transversum, left.	Medium sized pear. Pedicle. Ulceration. Inflammation.	2 mos. pain anorexia, constipation. 4 wks. ago vomiting. Abdominal tumor.	Laparotomy. Resection.	Recovery. Figures 13 and 14.
76.	Stetten, 1909.	Female, 36.	Lower ileum.	Fist. 10 x 8.5 x 4.5 cm. Circumference 16 cm. Weight 160 gm. Broad pedicle to mesentery.	2 yrs. Chronic ileocæcal invagination. Intermittent extrusion of tumor at anus, preceded by colic, constipation, feeling of something in abdomen. Abdominal tumor.	Laparotomy. Resection.	Recovery. Figures 1, 2, and 3.
77.	Stetten (Meyer), 1909.	Female, 20.	Colon transversum, left.	Large walnut. Ovoid. Sessile, at mesocolic angle.	3 mos., epigastric pain and vomiting in attacks of 4 hrs. after noonday meal, twice a wk. Abdominal tumor disappearing on inflation of colon.	Laparotomy. Resection.	Recovery. Well after 8 years. Figures 4 and 5.

From the study of the seventy-seven collected cases we may draw the following conclusions:

Sex. The sex is stated in sixty-one cases, of which thirty-two are males and twenty-nine females. There appears to be no particular predominance in either one of the sexes.

Age. The age at which the condition was recognized is noted in fifty-seven cases as follows:

Under 20	2
Between 20 and 30	7
Between 30 and 40	9
Between 40 and 50	15
Between 50 and 60	14
Between 60 and 70	6
Between 70 and 80	2
Over 80	2

The youngest patient was sixteen and the oldest eighty-seven years old, the average age being about forty-seven years. Over fifty per cent of the cases were found in individuals between forty and sixty years of age. This corresponds to the period of development of lipomata elsewhere. As is well known, these tumors usually develop in middle life when there is frequently an increased activity in the growth of the general adipose tissue. This is of importance from the diagnostic standpoint, as the time of the appearance of these growths seems to coincide with that of the carcinomata. Of course, it must be assumed that the slow growing lipomata may have been present for many years and that only after they have been in the gastro-intestinal canal for some time, after they have grown to appreciable size, or after they have caused mechanical changes by their long-continued presence, do they make themselves felt clinically, or they are only discovered as an accidental find on the autopsy table. This may account in part for their apparent greater frequency in the later years of life.

Location. The location is indicated as follows:

Stomach	3
Duodenum	7
Jejunum	5
Ileum	15
Meckel's diverticulum	1
Small intestine	2
Not indicated, possibly duodenum	1
Total small intestine	31
Cæcum	6
Colon ascendens	2
Colon transversum	4
Colon descendens	4
Sigmoid	7
Rectum	7
Colon	9
Not indicated, possibly colon	2
Total large intestine	41
Not indicated, apparently intestine	2

It will be seen that the growths appear almost as frequently above as below the valvula Bauhini, though they are very rare in the stomach. This is entirely contrary to either

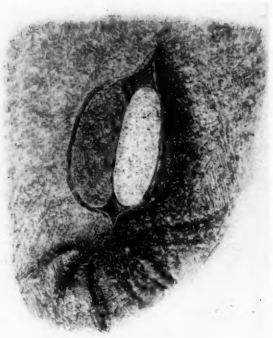

Fig. 7. Virchow's case of sessile submucous lipoma of stomach. Incised. Actual size.

the conclusions of Virchow, who states that they are most frequent in the stomach and upper part of the small intestine, or of Nothnagel, who claims that their favorite site is the rectum or lower ileum, or of Hiller, who found the condition fourteen times in the large and only five times in the small intestine. Though these tumors are supposed to occur in the appendix, no case has been recorded.

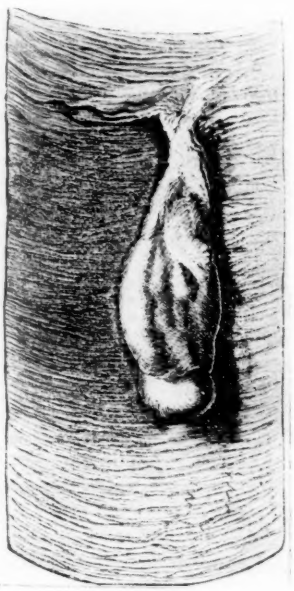

Fig. 8. Virchow's case of polypoid submucous lipoma of jejunum. Actual size.

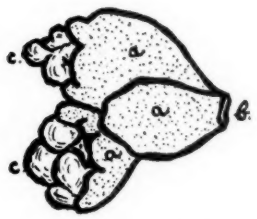

Fig. 9. Stabb's case of polypoid submucous lipoma of ileum. Actual size. *aaa*. Lobes of tumor. *b*. Common pedicle of attachment. *cc*. Ulcerated surfaces.

Number, size, and shape. The tumors usually appear singly. There may, however, be multiple growths (7 times). In one instance (Wallis) numerous tumors were found scattered throughout the entire colon. Huss reported a case in which twelve lipomata were found in the ileum, while Hahn discovered four in the same part of the intestinal tract, and Sangalli saw two in the descending colon.

They vary greatly in size, having been found as small as a pea or bean, and as large as a man's fist or a child's head, the larger tumors usually being found in the colon. The average size appears to be about that of a walnut.

The tumors protrude into the lumen of the gut, and may be lobulated and of irregular outline, though they are usually rounded, ovoid, or pyriform. The vast majority have a polypoid shape, and are attached to the gut by a narrow or broad pedicle of variable length (44 times). In eleven instances, however, it is distinctly stated that the growths were sessile.

Pathology. The tumors are never congenital and belong to the group of pure lipomata, being composed of fatty tissue with a greater or lesser network of connected tissue and blood vessels. Fischer, Knowlton, and Hellström (one case) have noted a considerable amount of connective tissue and have termed the tumors fibrolipomata. They are almost invariably circumscribed formations, and may show a distinct fibrous capsule, which may send tuberculæ into the growth, though as a rule their mucous membrane covering answers this purpose. Knowlton's case appears to have been a diffuse tumor, but the description is somewhat too vague for one to be certain.

Hæmorrhages into the tumor and peritoneal inflammation (Fischer), congestion (Fuchsig), inflammatory foci in the growth with or without injection of the serosa (Klein, Stetten), cystic degeneration (Hoyt), necrosis or ulceration of the mucosa (Hoyt, Tédenat, Stabb, Knaggs, O'Conor, Hellström, Klein, Hochenegg, Stetten), or even sloughing of part of the tumor (Gross, Fuchsig) have been noted. These changes depend to a great extent upon circulatory disturbances brought about by various mechanical factors which will be discussed later. These tumors show no tendency to malignant degeneration and in general have the biologic features of lipomata elsewhere. The mucous membrane over the growths is regularly atrophic and at times has ent rely disappeared, leaving a sclerotic connective tissue covering (Hellström). It may, however, be hypertrophic and adenomatous in places, with distention of the secreting cells (Stetten). The lymph follicles of the mucosa also atrophy, but the muscularis mucosa may be hypertrophied (Stetten).

Fig. 10. Bierring's case of multiple lipomatous polypi of intestine. One-third size.

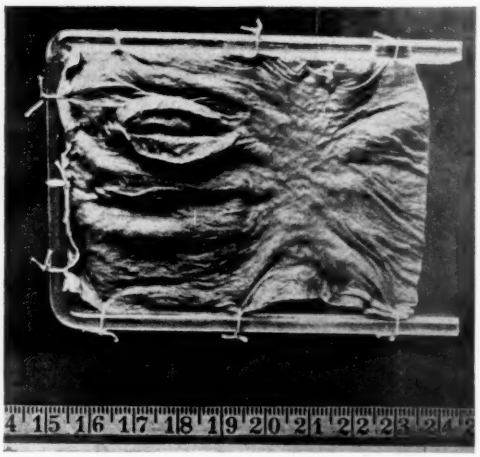

Fig. 11. Hemmeter's (Welch). Case of sessile submucous lipoma of colon.

The tumors spring from the connective tissue of the submucosa. They are simply an abnormal development of the fat regularly found in this layer. Link speaks of the lipoma in his case as having developed in the mucosa, but this is probably an error in diction. Fischer states that the tumor in his case sprang from the muscularis. It is possible that it was more subserous than submucous, as there was a distinct prominence of the serosa. In Marchand's case, the tumor is said to have been mainly subserous, though clinically it certainly belongs to the group we are studying. Ray's case is called subserous in the title, but this is clearly a mistake. Occasionally one or more subserous lipomata (Hahn, Hellström) are found in conjunction with the submucous variety, but there is no reason for assuming with Bland-Sutton, that the latter spring from the subserous or mesenteric fat and become submucous by forcing their way through the muscular coat. He comes to this conclusion because he and Stabb noted a dimpling of the serosa. Others (Fuchsig, Klein) have also observed this phenomenon, which is nothing but a beginning invagination and which may easily be explained by pull of the tumor from gravity or the peristaltic action of the gut. As a matter of fact in only six instances does the attachment of the pedicle correspond to the mesenteric border. As a rule the tumor develops from the free edge of the intestine, which fact, aside from the histological findings, is a powerful argument against Bland-Sutton's theory.

Frequency. Compared to the prevalence of carcinoma, the submucous lipoma is of course a rarity, but it is a relatively frequent form of benign tumor of the gastro-intestinal tract. According to Dewis, after the adenomatous polyp it is the most common.

As to the comparative frequency of their occurrence in relation to the distribution of

Fig. 12. Hochenegg's case of polypoid submucous lipoma of cæcum, showing invagination and ulceration of mucosa at apex of tumor. Long probe in ileum. Short probe in appendix. About two-thirds size.

Fig. 13. Klein's case of polypoid submucous lipoma of transverse colon. Incised. Actual size. Apex ulcerated.

lipomata elsewhere, the only available statistics are Brohl's, who found 10 intestinal lipomata in a collection of 391 and none in another group of 289 cases. While the former figures are probably an exaggeration in the one direction, the latter give just as erroneous an impression to the contrary. Hellström claims to have found 11 specimens (only 10 reported) in the Lund Pathological Institute, the majority of which were accidental post-mortem discoveries, and in the past eight years three have been removed by operation at the German Hospital (Fischer, Meyer, Stetten). As Hellström correctly suggests, this condition is in all probability much more common than is generally assumed, as practically only those cases, with few exceptions, which have caused decided clinical symptoms find their way into the literature. Surely many are never discovered and a considerable number have undoubtedly been observed on the autopsy table, which, being only of passing interest, receive no more publicity than a jar and label in a museum of pathology.

Duration, symptoms, and complications. Though there are no very definite data as to the length of time that these tumors may be present, the general impression is that they may exist for years. Most of the patients who have symptoms speak of having suffered for a long while,— for from two to sixteen years,— and it is probable that in the majority of cases, the tumors have been in existence for a much longer period. In Richardson's case there is a suspicion that the pathological condition had existed as long as forty years. On the other hand in some instances symptoms referable to the tumor have been present but for a few weeks or months, and not infrequently out of a perfectly clear sky a most critical clinical picture may develop within a day or two, or even with more startling suddenness.

The symptomatology of submucous lipoma of the stomach and intestines is a very complex one owing to the variety of location and size of the growths, but it can be divided into several groups. To a great extent the symptoms correspond to those caused by other benign tumors of these regions.

I. *Cases without symptoms* (21). In these cases, which naturally have no clinical significance, the condition is accidentally found post-mortem, death being due to some other disease, or it is discovered by chance during an intra-abdominal operation for something else. The tumors were usually of minor size [only once larger than a hazel nut (Kozielski)], fourteen were in the small, four in the large intestine, and two in the stomach, and in one the site was not indicated, but was apparently intestine.

II. *Cases with definite symptoms* (56). These are usually the larger tumors [only once smaller than a walnut (Coupland)].

1. *The stomach cases* (1). The case of Fischer is unique in that symptoms resembling an ulcer, with boring pain in the epigastrium due to a localized peritonitis, were present. It is the only case subjected to operation.

2. *The intestinal, exclusive of the rectal cases* (48).

A. Chronic intestinal symptoms with or without acute exacerbations (34). This forms a most important and characteristic group. For weeks, months, or years the patients suffer from vague and irregular abdominal symptoms occurring in typical attacks or more or less continuously. There is simply an uncomfortable sensation in the abdomen, or distinct pain, cramp-like or colicky in character, often diffuse but frequently localized to the region of the tumor, and sometimes occurring in relation to the meals (Albrecht, Hellström, Meyer). Appendicitis may be simulated (Ninaus, Bland-Sutton, Ward). In two instances the pain resembled that of biliary colic, due in all probability to duodenal tumors (Lewtas, Ward). At times, pains over the symphysis, not unlike those of labor may be present (Morel). Epigastric pain is not uncommon (Hellström, Meyer). The milder symptoms of discomfort are doubtless due to changes in the position of the tumor, and the pains are probably caused by a tugging of the gut by the peristaltic effort to expel the tumor or by a beginning invagination. The pain may last for hours and in a very characteristic manner suddenly disappear. A sensation of something moving about in the abdomen may exist (Bland-Sutton, Hellström, Stetten). Constipation is the rule, frequently alternating with diarrhœa. The constipation may amount almost to a chronic obstruction, may be accompanied by a distention, and is due to an invagination, obturation, or stenosis (Knowlton), though real obstruction due merely to the tumor is not the rule. If the nutrition of the growth has been interfered with on account of torsion or partial separation of its pedicle due mainly to the intestinal peristalsis, and its surface is ulcerated, the stools may contain blood, mucus, and pus. There

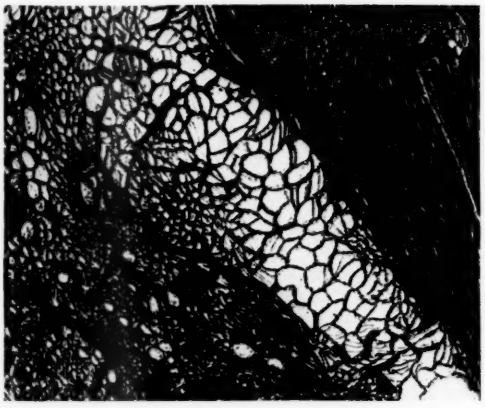

Fig. 14. Section from Klein's case, showing inflammatory infiltration of fatty tissue.

may be digestive disturbances such as anorexia, nausea, vomiting, and flatulence, and sometimes loss of weight. The vagueness of the symptoms and the usual absence of pure obstruction from the tumor itself are due partly to its mobility and elasticity, and partly to the lack of infiltration of the walls of the gut and the retention of their elastic and contractile properties. At times an abdominal or pelvic tumor is felt (12 times). If the tumors are situated low enough, or if the chronic invagination comes down far enough, the growth may be felt or seen at the anus (7 times). In the author's case a tumor of the ileum prolapsed externally. It should be emphasized that exacerbations of more acute obstructive symptoms with recessions are frequent. These cases usually terminate in one of three ways.

a. Operation (18).

a. Laparotomy (12). Usually with the diagnosis of malignant intestinal disease, particularly if a tumor has been felt, or, as in the writer's case, of high colon polyp, the patients are submitted to abdominal section. Simply the tumor (7 times) or a chronic invagination (5 times) is found and treated. Even at the operation the true condition may not be recognized and under the suspicion of malignancy, a more extensive resection may be done than is really necessary (Langemak, Hellström, Klein, Meyer). In all but two of the chronic invaginations, these cases were colon tumors.

B. Removal from anus (6). In tumors of the lower colon, if the growth has been felt per rectum, a diagnosis of polyp of the colon is usually made, and this is removed from below. The existing prolapse, which was invariably present, is reduced.

b. Spontaneous expulsion (10). Usually preceded by rather more acute symptoms, particularly tenesmus, the mass is passed and the patient is cured. When this occurs, the tumors are usually larger, six coming presumably from the colon, three from the small intestine and once not indicated. In Bauer's cases polypi were passed for seven weeks and in Bierring's case numerous polypi were passed over a period of six months with eventual recovery.

c. Development and persistence of acute intestinal obstruction (6). These cases correspond clinically to *B* (below) and were found in the small intestine five times and in the large intestine once.

B. Acute intestinal obstruction (14 + 6 under *c*). Either suddenly without warning, or after one or two previous milder attacks, or secondary to the train of chronic intestinal symptoms detailed above under *A*, an acute ileus develops and demands urgent operative interference. This is due usually to one or the other of the two following causes:

a. Intussusception (18). This is the more common cause of the acute obstruction. Clinically these cases are identical with the cases of acute invagination due to other causes, except that they occur in adults, and frequently have a previous chronic history. Abdominal palpation may show the sausage-shaped intussuscepted mass (4 times) or rectal examination reveals the apex of the intussuscipiens, especially if the lesion is in the lower part of the colon (once). Except in the case of the museum specimens it is recorded that in every instance operation was resorted to, with the single exception of Ninaus' case where a 120 centimeter piece of intestine with the lipoma was spontaneously expelled.

Before leaving this phase of the subject it is desirable that one point be emphasized, namely, the remarkable frequency of invagination as a result of submucous lipoma of the intestine. Of the sixty-seven intestinal, not including the rectal cases, we find 18 acute and 5 chronic intussusceptions and 6 chronic inversions of the lower colon. This gives a total of 29 cases or 43 per cent. Omitting the case where the tumor was an accidental find (19), we see that in 60 per cent of the intestinal cases in which symptoms were present an invagination existed. In every case the tumor was situated at the apex of the invagination. Of course this astonishingly large proportion is to a certain extent the natural outcome of the fact that those cases in which the complication was present are the ones that require operative interference, so that the lesion is discovered, and the case published. Most probably, as has been suggested above, numerous lipomata of the gut exist without symptoms or with such mild clinical signs that the bearers are never subjected to the knife and no diagnosis is made. As is well known, however, polypoid tumors are a very frequent cause of invagination, due to their weight or their production of active or irregular peristalsis. According to Treves' latest statistics 8 per cent of the cases of invagination have this etiological factor. Wichmann's statistics are also interesting. Among 134 cases of intussusception due to all varieties of tumors, 11 cases were caused by lipomata, which represents an unusually large percentage.

The location of the tumor causing the intussusception was 14 times in the small and 15 times in the large intestine. In other words, in all but 3 of the cases of small intestinal tumors in which symptoms existed (17) an invagination (12 acute and 2 chronic) was at the bottom of the trouble, while of the cases of large intestinal tumors with symptoms (31), not even half were invaginations, and of these more than 50 per cent (9) were chronic. This confirms, in a measure, the impression of Hiller, who with a very small number of observations decided that there was a much greater preponderance of acute invaginations in the tumors of the small intestine. Hiller's conclusions should, however, be modified. There is really no greater proportionate frequency of acute invaginations in small intestinal growths, for the above table shows 14 other cases without symptoms at all, but if the tumors of the small intestine reach a sufficient size, or have been present long enough to cause symptoms, these symptoms are usually immediately or event-

ually the result of an acute intussusception, which is not the case with tumors of the large intestine. This is easily understandable. The mobility of the small gut predisposes to invagination, if there is present an exciting factor in the shape of a tumor, while the greater fixity of the large intestine overcomes this tendency, and the narrower lumen of the former renders acute obstruction more probable if an invagination has occurred. Further the larger caliber of the colon permits of a tumor being present for some time, and growing to appreciable size before any symptoms whatsoever exist, and even after the disease makes itself felt clinically, the probabilities of a chronic course are much more likely. While acute obstruction does occur, particularly if the tumor is near the ileocæcal valve or in the more movable sigmoid, it will be delayed and surgical intervention to remedy the chronic ailment, or spontaneous expulsion of the tumor is a much more common event. Of the 28 purely chronic cases, 23 were probably colon tumors.

As lipomata are usually polypoid, naturally in the vast majority of cases where indicated, it is found that this variety has been the cause of the invagination (23 cases, including one of Meckel's diverticulum in which the diverticulum apparently acted as the pedicle) but twice sessile growths have been responsible. As is to be expected in the small intestine it has been the smaller tumors as a rule, and in the colon, the larger ones that have done the damage, though a large tumor (as in the author's case) springing from the small intestine, may be found causing the invagination, which may not even present urgent symptoms, provided the intussusception has become ileocæcal.

Depending upon the location of the growths any variety of invaginations may occur. The ileocæcal form was met with 9, the colonic, 11, and the jejunal or ileal 9 times, with a variation in extent from a few centimeters to over one and one-half meters.

b. Obturation from the tumor (2). Acute obstruction due to this cause has been noted twice. In Bland-Sutton's case there was a chronic history, and in Russell's there had been a previous acute attack. The abdominal mass was felt in both instances.

3. *The rectal cases* (7). These are simply disposed of. For a number of years, tenesmus, colic, digestive disturbances, and constipation or diarrhœa, with mucus and blood in the stools may be complained of, and the examining finger will detect a polypoid tumor within the anus, or the mere presence of the tumor may be the sole complaint (4 cases). Spontaneous expulsion (once) or removal from the anus (6 times) cures the condition.

Diagnosis. From this complex semeiology it is evidently impossible to give hard and fast diagnostic rules, and undoubtedly in many cases even a presumptive diagnosis will be most difficult, if not actually impossible. Something will have been accomplished by this paper if the surgeon's attention will but have been directed to the possibility of the presence of this lesion, either prior to or during operation, when he is face to face with an obscure abdominal case.

The stomach cases naturally offer great diagnostic obstacles. When gastroscopy has been perfected, this may be of assistance. It is conceivable that a growth near the pylorus might give the signs of a benign stenosis, most probably without a previous ulcer history, and if the growth be pedunculated, these symptoms might be intermittent in character.

In the duodenum, biliary or pancreatic obstruction with colic might exist, and clinically the case would obviously resemble a cholelithiasis.

In the rectal cases the existence of a polyp is evident. The exact pathological nature of this growth will probably be in doubt until the specimen is examined after operation, though its unusual softness, doughiness, pseudo-fluctuation and lobulation, and the yellowish shimmer through the red mucosa might suggest its true formation. This, however, is really immaterial. It must be remembered that retro- and ischio-rectal tumors, particularly lipomata, can protrude toward the gut and simulate submucous growths. This point is important, as the origin of the tumor would determine whether it should be removed per anum or from an external incision.

In the acute intestinal cases without previous symptoms it is only possible to say that an acute obstruction exists. If a sausage-

shaped mass be felt abdominally, if there is a bloody discharge from the rectum, and especially if the mass with lumen can be felt per anum, a diagnosis of intussusception is possible. A polyp may be seen or felt at the apex of this rectal mass. The age of the patient might lead one to suspect the cause of the intussusception, as spontaneous cases are rare except in childhood, and had there been a previous chronic history, this suspicion should be fortified, for the spontaneous invagination usually occurs suddenly.

In regard to the chronic cases, the long duration of the irregular symptoms, often for many years, their non-progression, the frequent lack of actual cachexia, the colicky attacks, the alternating constipation and diarrhœa, the digestive disturbances, the usual absence of blood and mucus in the stools, except during the more acute symptoms, and the exacerbations of more severe obstruction might lead one to assume the existence of a benign intestinal growth. If a soft, movable tumor is felt on abdominal examination, this assumption might be strengthened. This is particularly true, as Meyer emphasizes, if the mobility is pronounced. If the tumor varies in size and position, a chronic invagination is suggested. Should a distinct pedunculated rectal tumor be felt, one might say that an intestinal polyp existed.

While blood and mucus are infrequently passed in the lipoma cases and cachexia is rare, both symptoms can occur, and, as is well recognized, the stools in malignant disease very often are free from blood, and cachexia, especially in colon tumors which can remain latent for a long time, may be delayed for years. The age at which the lipoma usually becomes manifest corresponds to that of malignant disease, and the general symptoms to a great extent resemble those of cancer, so that diagnostic errors are very liable to happen, yet with a careful anamnesis and physical examination, it may be possible in a large proportion of cases to diagnose the presence of a benign tumor. To do better than this and make an exact pathological diagnosis will rarely be possible, and is after all of no particular moment.

Sarcoma of the gut develops earlier in life and usually shows its malignant nature promptly.

In cases where the symptoms point to the right iliac fossa, one's first thought will naturally be of appendicitis, but the comparative absence of peritonitic and infectious symptoms, the temperature, the blood examination, and the essential intraintestinal nature of the disease ought to aid in excluding this possibility.

The differential diagnosis from strictures, adhesions, etc., might offer difficulties, but the absence of a history of syphilis, tuberculosis, or enterocolitis on the one hand, or of previous peritonitis or operation on the other, will assist in the exclusion of these conditions.

The history and signs of an ileocæcal tuberculosis or of a nodular form of tuberculous peritonitis are usually so characteristic as to cause little trouble in diagnosis. The finding of bacilli in the sputum, and a positive Calmette or von Pirquet will also aid.

Gastric cancer has been suspected in colon tumors (Hellström), but inflation of the stomach and colon, examination of the gastric contents, etc., should clear up this question.

One might suspect the true pathological nature of the growth after it has once been decided that a benign tumor is present, if the patient is unusually obese or has a lipoma elsewhere (Albrecht). If the abdominal tumor is particularly soft, a fatty tumor should be thought of, though a hard tumor does not preclude lipoma (Meyer). If the tumor can be felt or seen per rectum, the softness, doughiness, pseudo-fluctuation and lobulation, and the yellowish tinge to the mucous membrane might as in the purely rectal cases, give a clue to its true character. If the growth is not easily within reach or sight, prostoscopy might be of service. Should fat masses have been passed spontaneously before and should the symptoms persist, the diagnosis of multiple intestinal lipomata is of course simple and the stool should carefully be examined for this evidence. It appears that this tendency to spontaneous expulsion is much more common with the fatty tumors than with the other benign intestinal growths.

Partial probatory excision from below is hardly indicated, for if it is evident that a polyp exists the plan of treatment is not influenced by the histological features of the polypoid mass.

It may occasionally be even possible to localize the tumor, even if it does not present at the rectum. The situation in the abdomen might be suggestive. A large tumor or one with more chronic symptoms is most probably in the colon. On the other hand one must not forget that a tumor of the small intestine even with chronic symptoms and of considerable size can be felt from the anus (Stetten). The localization of the pain may suggest the site of the growth; diffuse or umbilical, ileum; right iliac, ileocæcal; right hypochondriac, duodenum; epigastric, transverse colon; left iliac, sigmoid, etc. Finally, gastric and colon dilatation may be of assistance.

Prognosis. Although the fat tumor of the intestine, as such, is an essentially benign growth, its presence in the gut is a serious menance to the health and even life of its host, and it may prove to be very malignant for its possessor in particular instances.

The stomach and rectal cases are of no great consequence.

In a large percentage of the intestinal cases the tumor may cause no trouble at all or the case may go to spontaneous cure by expulsion of the growth. If the patient is operated upon in the absence of acute symptoms, the simple removal of the tumor either from above or below, with modern surgical technique is a comparatively harmless affair. Even the resection of a chronic irreducible invagination, though somewhat more hazardous, is not particularly dangerous under present conditions.

In the acute cases, however, the situation is radically different, and the prognosis becomes that of the acute obstruction, usually an intussusception. In the above table 11 deaths were directly due to the condition or to the surgical intervention. To these must be added three cases of museum specimens of invagination (Meckel, Sangalli, Turner), which, in all probability, were post-mortem findings and the cause of death. This is a death rate of 18 per cent of all the cases, of 20 per cent of all the pure intestinal cases, not including the rectal ones, of 25 per cent of all the cases with symptoms, and of 29 per cent of the intestinal cases with symptoms, exclusive of the rectal cases, which, though the fact that many of the cases were operated before the modern surgical era, must be considered, is nevertheless significant.

If might be mentioned that as tumors of the colon are more frequently expelled spontaneously, and as they may grow to larger size with more chronic symptoms, operation is more frequently resorted to under more favorable conditions than in tumors of the small intestine. On the other hand a large number of small intestinal growths escape observation entirely. Expressing these facts in a formula it might be stated that taking all the cases together, the prognosis of either type is about the same, but when symptoms are present the prognosis in colon tumor is decidedly the better.

Treatment. The therapeutics must necessarily be based upon the general principles of abdominal surgery. In the chronic intestinal cases operative interference is indicated and should be undertaken before the acute symptoms intervene. In the uncomplicated cases laparotomy and removal of the growth after enterotomy either by ligature of the pedicle or, if the tumor be sessile, by submucous enucleation and suture of the mucous, is the rational procedure. Excision of the wall of the gut at the site of the attachment of the tumor has been practiced (Fischer, Fuchsig), but this is an unnecessary complication of technique, provided the correct diagnosis of benign tumor has been made. It is extremely desirable that a diagnosis of at least non-malignant disease be reached, if not before, certainly during operation, so that the patient be not subjected to the needless risk of an extensive intestinal resection, when a simple opening of the gut, and removal of the tumor, would have been sufficient (Langemak, Hellström, Klein, Meyer). The movability of the tumor, and the absence of infiltration of the intestinal wall or of affected lymphatic glands will clearly show its benign character. On the other hand, cases have existed when even without further complication a resection was indicated, either on account of numerous tumors in a certain segment of the intestine (Hahn) or because of a diffuse growth not suitable for enucleation (Knowlton). In doubtful cases, of course, resection should be performed.

When a chronic intussusception is present an attempt should first be made to reduce this,

and the growth removed through an incision in the gut. If this is unsuccessful, resection of the invaginated mass with lateral anastomosis is the method of choice. In this procedure the control of hæmorrhage is much easier than in what is variously termed the Barker, Jesset, or Maunsell operation, unless the intussusception is gangrenous and the mesenteric vessels thrombosed. Further, the tendency toward a recurrence of the invagination is much less in a lateral anastomosis than in this invaginated end-to-end union.

In the acute intestinal cases a laparotomy becomes imperative, and the usual questions in dealing with an acute obstruction must be solved. If there is no invagination and the tumor is located it may be removed as in the chronic cases. Should there be an acute intussusception and should this appear reducible, reduction should be attempted. If this is successful, the bowel should be opened and the lipoma removed, and if the vitality of the gut has been impaired, the suspicious area must be resected. If the attempted reduction does not succeed, a regular resection or an enterotomy with resection of the intussusception at its base should be done. In the acute cases, this latter method is perhaps preferable, as it is a quicker operation and produces less shock. Should the condition of the patient not permit of more radical measures, an enterostomy above the obstruction must suffice; if the site of the obstruction is not readily found, one must content oneself with opening any dilated loop.

In the rectal or low sigmoid cases ligation of the pedicle or enucleation after splitting the mucosa may be done from the anus, and an existing prolapse reduced. Just one word of warning in conclusion. In operating from below, it is absolutely essential that the end of the attachment of the tumor to the intestine be accurately determined before any attempt at removal is made. Otherwise it is not at all unlikely that one may ligate off the apex of an intussusception, or what is almost as bad, include in a ligature, which may easily slip, part of the wall of the intraperitoneal colon, from which operation a fatal perforative peritonitis may readily develop. This accident occurred presumably to Hoyt, and likewise to Broca, who removed a high rectal adenomatous polyp by means of an écraseur without ligating.

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THE MODERN OPERATIVE TREATMENT OF FRACTURES OF THE PATELLA[1]

1. Based on the Study of Other Pathological States of This Bone. 2. An Analytical Review of Over 1,100 Cases Treated During the Last Ten Years, by the Open Operative Method

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DURING the last ten years, a very voluminous literature has been published on the open operative treatment of fractures of the patella. To this literature, clinicians of all nations have contributed. Since Lord Lister's first publication on the subject, many years have elapsed, and the indications, limitations and advantages of the open operative treatment over other methods of treatment have been discussed frequently in medical circles. The open operative treatment has advocates — has opponents. It is fast increasing in popularity. Many operators that had returned to the non-operative or subcutaneous operative modes of treatment are now employing for fractures of the patella, the open operative treatment. For instance, Koenig, who had returned to the subcutaneous methods, is now an enthusiastic advocate of the open methods.

Many different operative methods have been suggested, advocated, and practiced; numerous are the observations that have been collected and published, descriptive, condemnatory, and commendatory of these various methods. However, by far the greater number of the methods proposed have been abandoned, have been superseded by a few less objectionable, more preferable methods. Operative and clinical experience have led to the omission, to the elimination from the operative procedure of such steps as were found to be needless, of such steps as were found to be harmful, and to the introduction, and general employment, of some of great desirability.

Being of the opinion that our knowledge concerning fractures of the patella is as yet incomplete, I have collected the following data, hoping that it may prove of service to such investigators as feel disposed or called upon to elucidate the many points concerning these fractures, in reference to which our knowledge is defective. Being conversant only with the French, German, and English languages, I have not consulted, much to my regret, literature pertinent to the subject, published in other languages.

As yet, there is no uniformity of opinion, no uniformity of practice as to what should be done, as to what is done in the treatment of this condition. For instance, at the Cook County Hospital, of Chicago, from January 1, 1903, to June 30, 1908, inclusive, there were admitted and treated for fracture of the patella, 136 patients. These fractures were of various types, and all were treated by surgeons of acknowledged skill and experience. (Almost all, if not all, the surgeons of this institution are associated in a teaching capacity with one or another of the medical colleges of Chicago.) In examining the history sheets of these cases, some of which had been under my personal care, the dissimilarity of the methods employed by the various surgeons impressed me. Of these cases, some were recent fractures; some were fractures of long standing; some were treated non-operatively (60 cases); some were treated operatively (76 cases). Of the 76 operatively treated cases, the bony fragments were sutured in some (12) cases; in others, (25 cases) the fragments were circumferentially looped; while in most of the remaining cases (35), the operators deemed that the best results would and could be obtained by first apposing the bony fragments, and, then, merely suturing the lacerated peri- and parapatellar tissues. These different operators also differ in their conception of what is judicious post-operative

[1] I wish here to express my appreciation of Prof. Allen B. Kanavel's kindness for having placed at my disposal an abundance of anatomical and clinical material pertinent to the subject now under consideration.

treatment. We are all agreed that the operative procedure is only a part of the treatment of these fractures and that judicious pre- and post-operative care is an essential requisite to success.

It was further noted that some of these 76 patients were operated on the day following the injury; while in others, an interval of greater or less duration was allowed to elapse between the day of the infliction of the injury and the day of the performance of the operation. To expose the seat of fracture, the operators did not all use the same incision. It is stated that the incision employed was:

In some of these cases, the transverse incision was over the seat of fracture, in others, either above or below it.

Some of the surgeons in the Cook County Hospital, in cases of this nature, employ drainage; others consider it superfluous. In the opinion of several, the employment of intra-articular drainage is positively pernicious.

Some of the operators irrigated the articulation — (7 cases, 6 cases with Na Cl solution, 1 case with Hg Cl_2 1-1500 solution); others sponged it (5 cases); others neither sponged nor irrigated the joint cavity. In ten of the cases, bony fragments were removed from the synovial cavity. For the uniting of the divided soft and hard tissues, some surgeons used, in part or wholly, suture material of a non-absorbable nature; silver wire (25 cases), aluminum bronze wire (8 cases), copper wire (1 case); others exclusively used absorbable suture material; chromicized catgut (12 cases), pyoktanin catgut (6 cases), Kangaroo tendon (5 cases). In one case, the fragments were pegged. In some, the nature of the suture material employed is not definitely stated.

This diversity of methods employed by men of equal surgical attainments suggested questions to my mind. That these questions be accurately answered is of practical importance. These answers, we think, should be determined, should be arrived at, partly by theoretical consideration, partly by the study of the pathological anatomy present (as revealed at the operating table or at the autopsy room) in the knee-joints whose patellæ have been fractured, and, largely and mainly, by the clinical observation and comparison, from the anatomical and functional standpoints of the results obtained, by the employment of the various methods of treatment advocated and practiced.

Among the questions calling for a definite answer are the following:

1. Is the patella essential to the functional integrity of the knee-joint?

2. Are permanent displacements of the patella, in whole or in part, congenital or acquired, or the rudimentary development of this bone deformities significantly impairing the functions of the knee-joint?

3. Are there other traumatic lesions, simulating from the symptomatic standpoint, by the functional disturbances which they entail, fractures of the patella? What are these conditions? How are they best treated?

4. Which is the treatment of choice for fracture of the patella?

5. Is operation, at times, contraindicated? If so, when?

6. If operation is not always indicated, when is it indicated?

7. How should the treatment of old fractures differ from that of recent fractures, or is the same treatment applicable to both? If not, why not?

8. Which of the principal various open operative procedures that are now in vogue

for the treatment of fractures of the patella is the most universally applicable, the most satisfactory from the standpoint of early and of late results: transverse or longitudinal osseous suturing, looping of the patella (cerclage, Berger), hemicerclage (Quénu), or suturing of the peri- and parapatellar fibrous tissues (suture des ailerons, Vallas, retinaculæ patellæ, B. N. A., reserve extensor apparatus (Mickulicz)?

Questions of operative technique, concerning equally all the different open operative methods, must also be decided. Among them, are the following:

a. Should one, if he be an advocate of the open operative treatment, operate on the day or on the morrow of the infliction of the injury, or should he wait till the soft tissues have recovered from the immediate effects of the traumatism?

b. Should the operative field be rendered bloodless by the employment of an Esmarch bandage?

c. What should be the nature of the anæsthetic employed: local, lumbar, or general anæsthesia?

d. By what type of incision is the operator best enabled to perform the repair work which he deems appropriate and necessary?

e. Is it advisable in these cases to irrigate the articulation; if so, with what fluid, an antiseptic solution, irritating or non-irritating, or merely a cleansing agent, such as normal salt solution? Or is the mere sponging out of the extravasated liquid and clotted blood, from the synovial cavity, productive of the most satisfactory results?

f. Should non-absorbable, or absorbable, suture material be used? Are there any valid reasons for discarding non-absorbable suture material?

h. Shall the periarticular tissues be drained?

i. Shall the articulation be drained?

g. Shall the completely detached bony fragments be removed?

j. What should be the duration and the nature of the post-operative treatment?

Being convinced that the experience of any one individual is too limited to answer definitely and satisfactorily all these questions, I have carefully reviewed and studied the literature [1] published on this subject, during the last ten years in the languages stated above. From the American, English, French and German medical literatures, I have collected over 1,100 cases of fractured patellæ, which had been subjected to the open operative treatment. In our tables are included only such cases as were treated by the open operative method, that is, only those cases in which an arthrotomy was one of the preliminary steps of the operation. Thus, there figure in the appended tables only such cases in which, to restore the continuity of the fractured patella, there was performed one or more of the following operations:

Group A.	Either a plastic operation, transverse wiring of the fractured
No. of cases 33.	fragments, or hemicerclage. (Quénu, Paris.)
Group B.	A circumferential looping of the patella. (Cerclage, Berger,
No. of cases 28.	Paris.)
Group C.	Only a repair of the soft tissues. (Suture des ailerons, Vallas, Lyons.)
No. of cases 240.	Repair of the reserve extensor apparatus of the leg. (Mickulicz.)
Group D.	A longitudinal suturing of the bony fragments, one or more sutures
No. of cases 809.	being used.

In the cases of Group A, B, and D, the majority of the operators, in addition to performing the distinctive procedure characteristic of the group, sutured the torn subcutaneous tissues. In all these cases, it goes without saying that all errors of diagnosis as to the existence of a fracture have been eliminated, and what pathological data we have collected is authentic, is data the existence of which was demonstrated. Unfortunately, many of the reports are incomplete. So as to avoid misstatements and other inaccuracies, only original reports have been consulted. The tabulated cases are all authentic cases. We did not want to formulate conclusions based on erroneous statements. I have endeavored to state the results in the exact words used by the reporters.

These cases were not collected to support preconceived opinions, but to arrive at facts. We have taken them in the order in which we found them, and, also, as we found them. They are unselected consecutive cases. Cases

[1] Literature to which I had access, that is, all the Medical Journals kept on file at the John Crerar Library. Thanks are here extended to Gen. A. C. Girard, M. D., Medical Reference Librarian of the John Crerar Library, and to his efficient assistants for their unfailing and helpful courtesy.

too briefly reported are omitted from our tables. Having largely limited ourselves to the literature of the last ten years, our statements will be influenced thereby. One element of error which cannot be avoided is that operators feel a greater inclination towards giving publicity to successful than to unsuccessful cases. It is essential, in order to have an adequate understanding of the elements which enter into our conclusions, as well as for the formulation of rules for the scientific (from our viewpoint) treatment of fractures of this bone, that one should have some exact knowledge of the disabilities entailed by such pathological states as congenital or acquired displacement of the knee-cap, such anatomical anomalies as absence of the patella, congenital or acquired, as rudimentary development of the bone. Proceeding with our investigations, we became more familiar with two other conditions, which from the etiological, as well as from the symptomatological, pathological, and therapeutical standpoints, bear great resemblance to the solutions of continuity which occur in the patella. These two conditions are the open and the subcutaneous ruptures of the ligamentum patellæ and of the tendon of the quadriceps extensor femoris muscle. Both of these conditions, in time, we will consider briefly.

RUDIMENTARY PATELLA

Under normal conditions, the first rudiments of the patella appear about the tenth week of fœtal life and ossification usually begins from one center at about the third year after birth (H. S. Taylor). In some instances, this bone develops late in childhood, appearing at any time from the sixth month to the seventh year. It may or may not remain undersized, underdeveloped, throughout the patient's existence. Ewald refers to several cases of late development of the patella; in these cases at birth, the patella was apparently absent; later it developed and was of normal dimensions. Rudimentary patella is commonly associated with all congenital defects of the knee or limb that involve imperfect development of the quadriceps extensor femoris muscle (6). Three cases of congenital deficiency of both patellæ occurring in related individuals are reported by Pearson (7). In these three colored children, the patellæ were undersized and had developed tardily. It is reasonable to assume that undersized patellæ are structures of defective functional integrity.

CONGENITAL ABSENCE OF THE PATELLA

Between tardy development of the patella, and congenital absence of the patella, a distinction must be made. These two conditions are dissimilar and entail different functional disturbances. The patella may be congenitally absent in one knee, and rudimentary in the other. Congenital absence of the patella may be unilateral, may be bilateral. It may be, or it may not be associated with other congenital abnormalities in the same or in the opposite limb, or in either, or in both, of the upper extremities. Only when verified by radiography, is the diagnosis undoubted. It must, however, be kept in mind that the X-rays cannot demonstrate this bone previous to the beginning of its ossification. Ossification of the patella usually begins about the third or fourth year, in some instances as late as the seventh year. The bone is completely ossified at about the age of puberty. (Gray's Anatomy, Deaver's Surgical Anatomy.) In Piersol's Anatomy, it is stated "The bone is not fully formed till after puberty, perhaps not before eighteen."

In 1898, a series of 51 cases of congenital absence and of tardy development of the patella was published by Thorndike (2). In this series, Thorndike practically included all the cases recorded up to that time, and a few personal and other unpublished cases. It is specifically stated that 19 of these patients were males, and that 14 were females. In the other 18 cases, the sex of the patient is not definitely stated, the terms "infant," "child," etc., being used. In 29 of the above mentioned cases, the condition was bilateral; in 21 cases it was unilateral. In one case, the unilaterality or bilaterality of the condition is not recorded.

Owing to the frequent association with this condition of other congenital malformations, it is difficult to determine the exact extent of the functional disturbance dependent solely on the absence of the patella. For instance, congenital club-foot co-existed in 24 of the above mentioned cases; other forms of talipes,

in 5; in 5 other cases, the clinical picture was complicated by the existence of congenital hip-dislocation, club-hand, syndactylism, absence of fingers or toes. Absence of the fibula occurred several times. In all but one of these 5 cases, there was either impairment of power, of motion, or of both in the affected limb or limbs. Since the publication of Thorndike's article, despite the rarity of the condition, other cases of congenital absence of the patella have been reported. The following are undoubted cases: One, by Senftner (3), of total absence of both patellæ. His patient, a very active child, 4 years of age, could play ordinary games, but when it was necessary in any way to flex the knee-joint, as in walking up or down stairs, she was absolutely unable to accomplish the feat. Both limbs were habitually maintained in hyperextension.

Wuth (4) reports a case of congenital absence of both patellæ observed in an individual in whose grandfather, father, and three brothers, absence of the patellæ had been noted. The female members of the family had normal patellæ. In his interesting article, Joachimsthal discusses Wuth's case, and reports one case of unilateral double patellæ and one case of bilateral double patellæ. In Wuth's patient, a male, 35 years old, the absence of the patellæ was confirmed by palpation and by radiography. The anterior tibial tubercles were so markedly developed, that at first sight, one would have mistaken them for the missing bones. Outside of a slight tendency to varus, the absence of the patellæ was the only existent congenital abnormality. When this patient walked, his heels did not touch the ground.

Heine (5) in reporting a case of congenital bilateral absence of the patella, discusses this condition. In Heine's case, the diagnosis was verified by the X-rays. The tuberosities of the tibia and the condyles of the femur were well developed, and could be seen distinctly through the skin. On bending the knee, the tendon of the quadriceps extensor femoris muscle would slip over the outer condyle, giving to the fossa condylica the appearance of a deep groove. On further bending of the knee the quadriceps would slip medially. Function good.

A careful study of the reported cases, amply justifies the statement that congenital absence, unilateral or bilateral, of the patella, is always associated with some impairment of the functional integrity of the anatomically defective knee-joint or joints. This impairment in some cases is very slight; in other cases, it is considerable. In some of the reported cases we find mentioned, as contributory factors to the disability, one or more of the following conditions: Faulty insertion of the tendon, subluxation of the knee, hyperextension of the leg on the thigh, other associated congenital deformities or anomalies, etc.

ACQUIRED ABSENCE OF THE PATELLA

Nowadays, surgeons, owing to their better understanding of the principles of asepsis and antisepsis, show far less hesitation than formerly, to open the knee-joint for therapeutic purposes. Arthrotomies can now be performed with a high degree of confidence and security, and during the last decade, the removal, subperiosteal or total, of the patella, has been performed by different surgeons. There follows a table of all the cases (in which the removal of the patella constituted the sole operative procedure on the knee-joint) which I have been able to collect in the literature of the last ten years.

The patella has been removed for inflammatory affections, osteomyelitis, chronic (cases 5, 9, 12) or tubercular in nature (cases 3, 11, 14, 15); for fractures, transverse (cases 11, 17*a*), or comminuted (cases 1, 16, 17) in type; for primary malignant disease (case 13). A cursory study of the collected cases shows, among other things:

a. That this operation can be successfully performed under spinal (case 11) or under general anæsthesia.

b. That though the patella seems under certain conditions to be unessential for locomotion; nevertheless, its removal is invariably followed by impairment of power, by some functional loss. I have personally examined some of these cases, and though, as in Prof. J. B. Murphy's and in Dr. Cassius C. Rogers' cases, the patients have very serviceable knee-joints, it cannot be gainsaid that as a general rule, knee-joints without patellæ are impaired joints. To preserve the continuity of the extensor

TABLE I — ACQUIRED ABSENCE OF THE PATELLA

1. Scudder, G. S. Bost. Med. & Surg. Jr., 1898, vol. 138, p. 231. Comminuted fracture of each patella.		Comminuted fracture of the patella. The fragments were small and widely separated. Patella was removed.	Extirpation of the patella. The quadriceps tendon and the quadriceps fascia were sutured to the ligamentum patellæ. The fascia on each lateral aspect of knee was sutured across the front of the joint with 6 catgut sutures. A small wick of gauze was left in each side of the joint.	Knee presents a curiously flattened appearance. Outside of limitation of motion, knee is functionally as strong as if a natural or normal patella were present.
2. Hosmer, A.B. J. A. M. A., 1899, vol. 33, p. 916.		Ankylosed patella.	Extirpation.	Function restored to quadriceps extensor muscle. Results quite satisfactory.
3. Guibal. Bull. de la Soc. Anat. de Paris, 1899, vol. 1, p. 620.		Primary tuberculosis of the patella.	Subperiosteal removal of the patella.	One year after, patella had reformed. It was larger than normal. Slight limping. Active and passive flexion up to 45 degrees.
4. Dudley, Tait. J. A. M. A., 1900, July 28, p. 253.	Male, 54 yrs.		Owing to bad functional results, following non-operative treatment of fracture of the patella, the patella was removed.	Patient does not limp. Walks without difficulty.
5. Berger. Bull. de l'Acad. de Méd. Paris, 1901, 3 s. vol. 45, p. 69.		Chronic non-tubercular osteitis of patella, of more than 30 years standing.	Removed patella with the aid of a periosteotome. The tendon of the quadriceps tendon was united to the ligamentum patellæ, including in the same sutures the divided accessory parapatellar ligaments. Strong catgut used. Aponeurosis and expansions of vasti sutured with catgut. Drain inserted up to articulation.	Knee can be flexed beyond a right angle. Can fully extend knee. Can walk without limping and without undue fatigue. Limb is almost as resistant as the non-operated limb.
6. LeBoutillier, Annals of Surgery, 1903, vol. 37, p. 945. Excision of patella in extensive wound of knee.	Male, 30 yrs.	Falling rock caused an extensive lacerated wound of right knee. Transverse fracture of patella.	Both fragments were splintered to such an extent that they were removed. Nineteen days after, skin-grafts applied to raw surfaces.	Motion of limb is restricted. Good extension. Poor flexion. Restriction of motion largely due to adhesions of the cicatrix to the femur. Extension was now brought about by the vastus internus.
7. Joachimstal. Angeborener Mangel der Kniescheibe Deutsche Med. Wochenschrift Vereinsbeilage 1904, Vol. 30, p. 297.	Male, 34 yrs.	Congenital absence of the patella. Outside of some difficulty in jumping, there was no disturbance of function. Father and one sister had same deformity.	Tibial tubercles well developed. Also had congenital dislocation of head of right radius.	
8. Ewald, P. Über congentale Luxation sowie angeborenen Defect der Patella combinirt mit Pes Varus congenitalus. Archiv. für Klinische Chirurgie, 1905–'06, vol. 76, p. 824.	Female, 12 m.		X-ray does not reveal presence of patella. Atrophy of quadriceps femoris. Impairment of function.	Had congenital club-foot.
9. Creite. Deutsche Zeitschrift für Chir., 1906, Vol. 83, p. 179. Beiträge zur Pathologie der Kniescheibe.	Male, 18 yrs.	Influenza 5 mos. previously. Abscess of the patella, containing a thin greenish yellow pus and thick granulation masses. Germs conveyed to the patella by the way of blood vessels.	Transverse incision. Patella extirpated. Quadriceps tendon sutured to the ligamentum patellæ.	Recovered from the operation. Stiff knee resulted.

TABLE I — Continued

10. Andrieu, J. Tuberculose primitive de la rotule, envahissement de la synoviale du genou. Revue mensuelle des maladies de l'enfance. Par., 1907, vol. 25, p. 324.	Female, 12 yrs.	Primary tuberculosis of the patella. Left knee. Six years' standing.	Longitudinal incision. Extirpation of patella.	Knee can be flexed beyond a right angle.
11. Willis W. Morley. Lancet, 1907, vol. 11, p. 1689. 3 cases. One patient was presented to the Nottingham Medico-Chirurgcal Society.	Male, 25 yrs.	Simple fracture of right patella.	Sutured tendon of quadriceps extensor femoris to ligamentum patella.	In one case, functional result not perfect. In two cases, result was excellent.
12. Rouvillier. Revue de Chir, Paris, 1907, vol. 35, p. 320.		Fracture of the patella in which the bone was circumferentially wired. Osteitis followed.	Removed patella. Quadriceps tendon was sutured to the ligamentum patellæ.	Excellent functional result.
13. Kudlek, Franz. Deutsche Zeitschrift für Chir., Leipzig, 1907, vol. 88, p. 139. Beitrag zur Pathologie und Physiologie der Patella.		Primary sarcoma of the patella.	Operation under lumbar anæsthesia. Longitudinal incision 12 cm. long. Extirpation of the patella. Suture of the tendon of the quadriceps extensor to ligamentum patellæ.	Can carry 200 lbs up stairs. No recurrence. Function and endurance of knee joint absolutely normal. One year later, still O. K.
14. Mayo, Wm. J. Surg. Gyn. & Obst., Chicago, 1908, vol. 6, p. 313.		Tuberculosis of patella.	Removed patella.	Very good result.
15. Murphy, J. B. Surg. Gyn. Obst., Chicago, 1908, vol. 6, p. 262. 2 cases.		Primary tuberculosis of patella.	Lateral incision from 15 to 20 cm. to outer side of patella. Patella dissected out subaponeurotically, leaving ends of quadriceps tendon and ligamentum patellæ exposed. Synovial membrane closed with continuous catgut sutures. The flap prepared by splitting the quadriceps tendon and the vastus extensor muscle, is turned downward with its fascial side to the joint. It is united to the patellar ligament end to end or may overlap. Row of interrupted kangaroo sutures between ligamentum patellæ and quadriceps extensor flap. The rent left in vastus externus is closed by buried sutures. Horse hair in skin. 3.4 anterior splint.	Good functional result. In case 1, patient is able to go up and down a hall or stairs with slight inconvenience. In case 2, can extend leg on the thigh perfectly. Can flex it to a full right angle. No pain. No discomfort:
16. Scudder, Chas. L. Ills. Med. Jr., 1908, vol. 13, p. 691.		Fracture of both patellæ. Marked comminution. Bones were so literally smashed that they could be rendered of no use to the patient.	Both patellæ removed. Quadriceps tendon sewed to the patellar tendon.	Functional use of both knees excellent.
17*a*. Rogers, Cassius C. Ills. Med. Jour., Springfield, 1908, vol. 13, p. 648.	Male, 30 years.	Three years previously had sustained a transverse fracture of the patella. Treated non-operatively. Began to use leg after seven months. 11 months after first fracture, refracture occurred. The patella was then wired. Failure of union. Fifteen months after this fracture, patient fell.	Patella removed. The tendon of the quadriceps extensor was cut across from left to right at its origin from the muscle, the incision extending only half-way through the tendon antero-posteriorly. The tendon was now split to within a short distance, ½ inch, of its patellar attachment and the flap thus formed reflected downward and sutured to the patellar tendon. Patella tendon sutured to quad. ext. tend. No. 3 catgut. Interrupted sutures. Skin sutured with interrupted silk wormgut.	Wound healed by primary union. No discomfort. Flexion to a right angle. Extension almost complete.
17*b*. Rogers, Cassius C. Communication Personal.	Female, 26 years. Nurse.	Fell and struck knee against curb. Comminuted fracture. Expectant treatment 6 weeks. No union. Absolute loss of extension.	Patella removed. Same operation as 17*a* was performed.	Recovery. Extension perfect. Flexion to right angle.

apparatus of the leg, to conserve the stability of the knee-joint, after removal of the patella, the gap left by its extirpation must be obliterated, by suturing the tendon of the quadriceps to the ligamentum patellæ, and by such operative measures, plastic or other, as may be indicated in the individual case. The extirpation of the patella is always a sacrifice. Its loss deprives the knee-joint of the protective influence which this bone affords to the articulation, this sesamoid bone being an important factor in the distribution over a considerable area of any force applied to the front of the knee. The patella provides considerable leverage for the quadriceps muscle and its removal is followed by a weakening and an impairment of the action of the quadriceps extensor tendon upon the leg. All sesamoid bones are mechanical accessories of the tendons in which they are partially or completely embedded. By this sesamoid bone, the tendon of the quadriceps is kept spread out and prevented from being gathered up in a round cord. The patella forms a much more suitable pulley for movements round the condyles than the tendon itself, and in addition, serves a minor purpose in keeping the upper end of the patellar ligament in a plane well in front of the axis of flexion and extension. In uncomplicated transverse fractures of the knee-cap, the extirpation of the patella as a form of treatment is to be condemned. In comminuted fractures, it deserves consideration only as a measure of last resort. In inflammatory and neoplastic disease of the bone, extirpation is a valuable resource. In primary malignant neoplastic disease, no one questions the wisdom of its removal.

The preceding observations demonstrate conclusively to our mind that the patella is not a useless structure and that a deficiency or an absence of this bone, congenital or acquired, is invariably associated with an impairment of the functional integrity of the knee-joint.

CONGENITAL DISLOCATION

Having satisfied ourselves that congenital or acquired absence of the patella entails disability, the next step to determine was whether the displacement or the abnormal location of this bone in its entirety, has any influence on locomotion or on the weight-bearing function of the knee-joint. Traumatic dislocations of the patella entail disturbances that are known to us all. Furthermore, in traumatic dislocations, (that is, in the permanent separation, partial or complete, of the two articular surfaces, femoral and patellar, which are normally in contact,) associated injuries of the surrounding soft tissues always co-exist. As in traumatic fractures, in traumatic dislocations, it is not easy to determine what proportion of the loss of function is due to the separation of the articular surfaces, what proportion is due to the co-existing inflammation of the knee-joint, and what proportion is dependent on the associated laceration of the surrounding tissues. Therefore, we will not discuss traumatic dislocations, neither will we discuss habitual dislocations, the resultant either of the former, or of previous articular disease. We will say a few words about congenital dislocations of the patella, because here in the absence of other associated, congenital, or acquired, abnormalities, the disturbance of function must be, and is, due, primarily, to the displacement of the patella.

The etiology of congenital dislocation of the patella is still unsettled, is still undetermined. It is more frequent in women; in them the condition of physiologic genu valgum is more marked. By some, genu valgum is considered an exciting cause, by others, only a predisposing cause; while some look upon genu valgum as an effect, instead of a cause, of the condition. Supracondylar osteotomy of the femur, whether cuneiform or linear, does not always permit of the reduction of the deformity (Bullinger-Muller) (8). Other observers regard heredity, abnormal intrauterine pressure, abdominal traumatism, as causative, as determining factors.

There can be demonstrated in nearly all cases of congenital dislocation of the patella, either a flattening, a deformity, a deficient development, or a total absence of the external femoral condyle. Owing to this structural deviation of the external condyle from the normal, a slight traumatism, a slight contraction of the quadriceps can easily determine a subluxation or a luxation of the patella. Zesas (9), in three-fourths of his collected cases, finds

mention of a more or less marked deformity or total absence of the external condyle.

Congenital dislocation of the patella is a condition of less uncommon occurrence than congenital absence of the patella. It is found more frequently, by far, in females. It may be unilateral, or bilateral; may be complete, or incomplete; may be permanent, or intermittent; may or may not be associated with other developmental abnormalities. Torsion outwards of the tibia and torsion inwards of the femur not uncommonly co-exist, and almost all cases are associated with genu valgum. Zesas (9), published, in 1902, a list of 64 cases of this condition, which he collected from the medical literature. Outside of three cases, they were all outward dislocations. In this series, it is stated that the dislocation was on the left side 14 times, on the right side 14 times, and bilateral 31 times.

In looking up the literature we found that many cases of dislocation (habitual or recurrent) of the patellæ due to traumatic or pathologic cause are reported as congenital dislocations. We have endeavored to be precise and to eliminate from inclusion in Table II, cases, the nature of which could be controverted.

The patella, being a sesamoid bone, cannot undergo any upward displacement unless there be an associated relaxation or rupture of the ligamentum patellæ; cannot be dislocated downward without either an associated relaxation or an associated rupture of the quadriceps extensor tendon.

In Zesas' series there were 3 cases of intermittent incomplete dislocation; 13 cases of complete and intermittent luxation; in 11 cases, the condition was incomplete and permanent; in 29 cases it was complete and permanent. In the appended table (table No. 2) will be found all the cases of congenital dislocation that have been published since the appearance of Zesas' article, and also a few not included in his list. (That is, published in the medical literature to which I have had access.) Its perusal is not uninteresting.

Ordinarily, the subjects of this deformity begin to walk late (case A never walked until her seventh year). Atrophy of the quadriceps extensor femoris muscle of the involved limb or limbs, was noted in cases C, D, E, H, I, K, O, R, T. Genu valgum co-existed in cases A, C, G, I, J, M, P, R, T. In all the cases, there was functional impairment, manifested by difficulty experienced in going up or down stairs (cases D, J, K, M, T), by a feeling of uncertainty or weakness in the affected limb or limbs (cases C, E, J, P), or by a tendency to fall (cases A, M, N, P). Some of the patients were subjected to operation. Lessened disability resulted.

Our first statement was, that absence of the patella, congenital or acquired, is always associated with some impairment of the functional integrity of the knee-joint. This functional impairment may be slight, may be markedly disabling. Our second statement is, that any dislocation of the patella, be it intermittent or permanent, be it complete or incomplete, be it congenital or acquired, is also always associated with some impairment, slight or severe, of the functional integrity of the knee-joint. The fact that operations have been devised and performed for the remedying of congenital dislocations of the patella, is another proof that anomalous location of the patella entails disability. The third statement, which we shall forthwith endeavor to prove, is that all upward or downward displacements of the patella as a whole, if dependent upon rupture of the quadriceps extensor femoris tendon, or of the ligamentum patellæ, will cause symptoms somewhat analogous to those which are caused by complete transverse, oblique, stellate, or comminuted fractures of the patella. Violence of the same nature can determine a solution of continuity of either the tendon, the patella, or the ligament.

The force that indirectly produces the solution of continuity is obviously exerted equally on the quadriceps tendon, on the ligamentum patellæ, on the tuberosity of the tibia and on the patella; but fracture of the patella is by far the most common result of such indirect violence.

Traumatic or pathological, open or subcutaneous, ruptures of the quadriceps extensor femoris tendon, may, like fractures of the patella, be complete or incomplete, be unilateral or bilateral. They may be associated with, precede, or follow a fracture of the patella.

TABLE II—CONGENITAL DISLOCATION OF THE PATELLA

a. McLaren, Shaw. The Lancet, 1900, vol. 1, p. 238.	Woman, 19 yrs.	A congenital dislocation. Left side. Also marked left genu valgum. The knee is rotated outwards.		Never walked securely. Never walked until the age of 7. She could never run. Was always falling. When the knee is extended, the patella lies to the outside of the normal position; when the joint is flexed, it passes further and further until it lies on the outside of the external condyle. The patient has frequent attacks of synovitis.
b. Schanze. Rev. d'Orthopédie, Paris, 1901, vol. 1, p. 483. Traitement de la luxation habituelle de la rotule.	Female, 12 yrs.	This is a case of habitual dislocation. Bilateral dislocation of both patellæ. Left knee more involved than the right. Both patellæ could be luxated by simple pressure.		Operation. Recovery.
c. Elliott, Geo. R. N. Y. Med. Jr., 1901, vol. 73, p. 748.	Male, 20 yrs.	Right patella. The right thigh shows a circumferential atrophy of 2 in. Slight degree of knock-knee existed.		On extension of leg the patella slipped into place, but on flexion, even if force was applied to hold it in place, it slipped over the external condyle of the femur. All that the patient complained of was a sense of weakness and uncertainty in the leg.
d. Friedländer. Rev. d'Orthépdie, Paris, 1901, 2nd ser., vol. 2, p. 309. Luxation habituelle de la rotule.	Male, 12 yrs.	Patient had dorso-lumbar scoliosis.	Intermittent luxation of left patella. The patella would dislocate itself spontaneously or passively as soon as flexion of the knee exceeded 155 degrees. The author also cites a case of habitual bilateral outward dislocation of both patellæ occurring in a child. A certain degree of atrophy of the quadriceps extensor femoris muscle is present. Child is easily fatigued. Must rest often. Finds special difficulty in going upstairs.	Patient had difficulty in going up stairs and down.
e. Judet et Touchard. Bull. de la Soc. de Pédiatrie de Paris, 1903. Also Revue d'Orthopédie, 1906, 2d serie, vol. 7, p. 73.	Male, 15 yrs.	Left patella. Also, bilateral ectopia testis. Left quadriceps extensor femoris muscle is atrophied. There was a co-existing congenital bilateral dislocation backward of head of radius.		Some interference with locomotion.
f. Jeney. Der Militärarzt, Wien., 1903, vol. 38, p. 31.		Complete congenital luxation of patella.		Function completely normal. Patella somewhat smaller than opposite patella.
g. Stewart. Ann. of Surg. 1904, vol. 39, p. 452.	Male, 39 yrs.	Congenital bilateral dislocation of both patellæ. Patellæ rested on the external surfaces of external femoral condyles. Bilateral knock-knees.		The internal edge of patella looked forward. Anterior surface facing outward. Condition verified by X-rays. It was associated with brachydactylia. When the knee is flexed, the patella passes farther outward and backward until it touches the head of the fibula.
h. Bérard. Lyon Med. 1904, vol. 103, p. 880. Luxation Congénitale des deux rotules.	Female, 13 yrs.	Bilateral dislocation of patellæ. Marked bilateral genu-valgum. Marked atrophy of external condyle. Quadriceps extensor underdeveloped.		Long walks cause the patient pain. Operation.
i. Nau, P. Bull. et Mém. de la Société Anatomique de Paris, 1904, vol. 6, p. 178. Anat. Luxation Congénitale de a rolule.	Female, 25 yrs.	Left patella. Left genu-valgum co-exists. Slight atrophy in height and in width of external condyle. Verified by X-Rays. No rachitic stigmata.		Patient began to walk when five years of age. In extension the left patella is dislocated outward, and then is applied against the external surface of the external condyle. Limping is barely perceptible.
j. Ewald, P. Über Congenitale Luxation sowie angeborenen. Defect der Patella, combinirt mit Pes Varus congenitus Archiv. füer Klinische Chirurgie, 1905–1906, vol. 76, p. 824.	Boy, 6 yrs.	Inner border of left patella corresponds to outer border of external condyle. Bi-lateral Genu-Valgum.	In flexion, the patella is displaced outward, its inner-border looks forwards, and its cartilaginous surface lies upon the outer surface of the external condyle.	Function good. Some difficulty in going down stairs. Some uncertainty; some instability of knee-joint.

TABLE II — Continued

k. Bullinger-Müller. Rev. d'Orthopédie, Paris, 1906, 2nd Ser., vol. 7, p. 59. De la luxation congénitale de la rotule.	Male, 9 yrs.	Left patella. Began to walk at age of 10 months. Had talipes valgus which made walking difficult. The luxation of the patella was the cause of frequent falls. Some atrophy of quadriceps extensor m. (centimetos).		Walking is very painful. Often, has to sit down. Has great difficulty in going up and down stairs. Operated. Some improvement.
l. Wullenstein. Eine neue Behendlungsmethode der kongenitalen Luxation der Patella. Münch. Med. Wochenschr, 1906, vol. 53, p. 936.		Bilateral congenital outward dislocation of patella. Author claims that there is a disproportion between the under and outer parts of capsule.		Patient benefited by operation.
m. Bogen, Heinrich. Zeitschr. f. Orthop. Chir., 1906, vol. 16, p. 359. Case 1.	Female, 51 yrs.	Some physicians had diagnosed absence of patellæ, but both patellæ were found. They were abnormally small. Bilateral genu-valgum. Patient had no patellar reflex.		Walking moderately difficult. Much trouble in going up or down stairs.
Case 2.	Female, 29 yrs.	Second daughter of above. Left knee, outward permanent luxation of every small patella. Right, incomplete outward luxation of patella. Patellæ are smaller than normal.		Functional impairment. Falls frequently. Has difficulty in going up or down stairs.
Case 3.	Male, 29 yrs.	Son of Case 1. Flattened knee-joints. On outer side of joints the bean-sized movable patellæ can be palpated. Located on the outer sider of ext. femoral condyles. Bilateral genu-varus.		Perfect function.
Über familiäre Luxation und Kleinhaut der Patella.				
n. Goodman, Chas. Med Rec. N. Y., 1906, vol. 69, p. 729.	Male, 13 yrs.	Right patella. Upon flexing the right knee, the patella overrode the external condyle of the femur, and by voluntary contraction of quadriceps femoris, the boy was able to dislocate patella completely outwards. There was no deformity of the femur.		His frequent tendency to fall prevented him from enjoying games in which jumping and running were features of the sport.
o. Bullinger-Müller. Rev. d'Orthopédie, Paris, 1906, 2 ser., vol. 7, p. 72.	Female, 54 yrs.	Left patella. Began to walk at about 12 months. During entire childhood, fell frequently. The entire left limb in all respects shows poorer measurements than the right. Left patella seems to be smaller than the right. The former being 1 cm. smaller than the latter.		With the flexion of the limb, the left patella displaces itself to the external surface of the left external condyle. Condition easily diagnosed by inspection and palpation.
p. Drew, Douglass. Transactions of the Clinical Society of London, 1907, vol. 40, p. 275.	Female, 13 yrs.	Right patella. Genu-valgum. Muscles of thigh smaller than on other side.	McEwen's osteotomy was performed.	Some weakness of knee complained of on flexing the knee. The patella slips completely over to the outer surface of the external condyle, whereas when the knee is extended it lies over the external condyle.
q. Steaddon. Lancet, 1907, vol. 2, p. 1207.		Left patella was dislocated outwards.		Patient suffered no inconveniences, being able to walk and ride a bicycle like a normal individual.
r. MacLennan, Alex. Glasgow Medical Journal, 1907, vol. 67, p. 30.	Female, 14 yrs.	No signs of rickets. Atrophy of vastus internus. Slight genu-valgum.		Operation. Some improvement.
s. Elsberg, Chas. A. Annals of Surgery, 1907, vol. 45, p. 777.	Male, 14 yrs.	Condition grew worse with age. As soon as leg was flexed to 45 degrees or beyond, the patella would be dislocated backward and outward so as to lie on the outer part of the popliteal space.	Operation. Lengthening of tissues on outer side of the patella. Shortening of tissues on inner side of patella.	Excellent result.
t. Bogen Heinrich. Zur Kasuistik der kongenitalen Luxation der Patella. Münch. Med. Wochen., 1907 vol. 54, p. 670.	Female, 5 yrs.	Left patella. The whole limb somewhat atrophied. Patella smaller than opposite patella. Left genu-valgum. Ext. condyle under developed.		Has difficulty in going up stairs. In going up or down stairs, she always has to put her right limb forward. Began to walk at the age of 2 years. Had frequent falls.

TABLE III — TRAUMATIC RUPTURE OF THE QUADRICEPS EXTENSOR TENDON

1. Riegner. Allg. Med. Zentralzt, 1901, vol. 70, p. 31. Verletzungen am Kniestreckapparat.	Male, 50 yrs.	Complete rupture of quadriceps extensor femoris tendon. 2 cm. above its insertion in patella.	Crescent shaped incision exposure. Divided ends of tendon approximated by 4 thick catgut sutures. No drainage. Immobilization.	Excellent result. 7 weeks after, complete recovery.
2. Koerte. Vorstellung eines Kranken mit Abreissung der Quadriceps sehne von der Kniescheibe. Naht. Deutsche Med., Wochenschr, Leipz., 1901, 27, ver. Beil. 175	Male, 54 yrs.	Horse kick on knee. Loss of power of extension of leg. Hiatus.	Operation 12 days later. Convex incision. Quadricipital tendon had been torn off from upper margin of patella. Tendon sutured with catgut. Capsular tears also sewed with catgut.	Recovery. Function almost normal.
3. Israel. Same Bib. reference as above. p. 176.	Male.	Tendon torn 1 finger's breadth above upper margin of patella.	Oper. 8 days after injury. Longitudinal incision. The appearance of the tendon was abnormal. Rent in tendon sutured with silver wire.	Not stated.
4. Sonnenburg. Same as above. p. 176.	Male, Adult.	Sulcus in course of tendon corresponding to gap between proximal and distal margin of tear.	Transverse incision. Sutured tendon.	Excellent functional recovery.
5. Delaye. Archives Provinciales de Chirurge, 1901, vol. 10, p. 482. Du de doublement de la rotule appliqué à la cure des ruptures totales et anciennes du tendon tricipital.		Immediately above base of patella the femoro-tibial interarticular line can be easily palpated. Complete loss of extension of limb. Walking impossible. Tendon completely divided close to base of patella. Gap in quadriceps extensor muscle was nearly 7 cm. in length.	Operation two months after accident. Longitudinal incision, 12 cm. long. Patella divided in 2 antero-posterior halves. The anterior half of patella was turned upwards, and united by sutures to the retracted quadriceps tendon. The two halves of patella were united hinge-like at their point of contact by two metallic sutures.	Walking is easy. Extension complete. No weakness of limb.
6. Norris, H. University of Penn. Med. Bulletin, 1903, 1904, vol. 16, p. 367. Rupture of the Quadriceps Extensor Tendon with Report of a case.	Male, 48 yrs.	While jumping from a slowly moving train, patient lost his balance and fell forward on his right knee. Patient could only hobble with difficulty. Extension of leg not possible. ½ in. above patella is a transverse depression, about one finger's breadth in width.	Longitudinal incision. directly over the outer aspect of limb. V-shaped tear (almost complete) of tendon. Capsule of knee joint had been torn by injury. Ends of tendon freshened and uinited by 3 sutures of formal gut stitches.	Six weeks after operation patient had perfect use of limb and was able to resume former occupation. This author collected 27 cases in which the tendon were ruptured, they divided tendon was sutured in all cases: Twenty-seven complete cures resulted.
7. Stewart, Francis T. Annals of Surg., 1904, vol. 39, p. 603.	Sailor.	Had quadriceps extensor tendon severed by a knife thrust. 3 months after injury, the joint was still distended with fluid. There was a distinct depression above the patella, Patient unable to extend leg.	Anterior incision. Severed ends of the tendon were found separated 4 inches in the middle line, this distance diminishing as the muscle at either side were approached. Divided ends approximated and sutured with kangaroo tendon. Knee immobilized 3 weeks.	Functional result perfect. Patient able to work in rigging as before operation.
8. Wharton, Henry R. Ann. of Surg., 1904, vol. 39, p. 273.	Male, 60 yrs.	Fell. Could not walk. Simultaneous rupture of both tendons about 1½ in. above the patella. Loss of power of extension of knee-joint.	Longitudinal incision 4 inches over the position of rupture in each tendon. The gap between the ruptured ends of the tendons in each case were filled with blood clot and synovial fluid. The bursæ above the patella was ruptured and portion of the blood clot extended under the patella and into the knee joints. Ends of tendons freshened and surfaces brought into contact by the introduction of 4 heavy chromicized catgut sutures. The fibrous tissues over tendons were brought together with buried sutures. Immobilization.	3 months after, restoration of function complete.
9. Blume, Sam. American Medicine, 1904, vol. 8, p. 1038. Rupture of both Quadriceps Extensors.		So as not to fall forward, patient threw up both arms, bending backward, and in so doing, tore both quadriceps extensors. The right about ¾ in. above; and the left, about 1½ in. above the potella. Fascia were also torn on both sides.	Operation 5 days later. Over seventy chromicized ligatures were used in bringing tendons and fasciæ together.	Remained in hospital three months and one day. Eventually could walk as well as ever.
10. Doebbelin. Deutscher Militärárzt, Zeitsch, 1906, vol. 35, p. 623.	74 yrs.	In slipping, complete rupture of quadriceps extensor femoris muscle. Capsule not injured.	Open suture.	Complete recovery.

TABLE III — Continued

11. Albrecht. Wien Klin. Woch., 1906, No. 22, p. 683.	49 yrs.	Hyper flexion was cause of accident. Subcutaneous bilateral rupture of the quadriceps extensor tendon. Capsule of joint lacerated. Bursa supra patellaris opened.	Open operation. Suture of torn tendon.	4 weeks after the operation first attempt to walk. Good recovery.
12. Masini. Bullet Mém de la Société Anatomique de Paris, 1906, 6 e. série, vol. 8, p. 554.		Division of quadriceps tendon 3 cm. above the base of the patella. The synovial membrane showed no tear.	Esmarch band to limb over tendon sutures. The lateral portions of the tendon were united each by a U-shaped suture. The continuity of the median portion was re-established by six interrupted catgut stitches. Deep fascia united, skin sutured with silk worm gut.	19 days after operation patient could flex knee to a right angle.
13. Wolf, W. Beiträge zur klinischen Chirurgie, 1907, vol. 55, p. 490. Zur Kenntniss der subcutanen Muskelruptur und ihrer operativen Behandlung.	Male, 31 yrs.	Rupture slightly above insertion in patella. Marked weakening of extension.	Six months after injury, operation. Tendon united with catgut.	Five weeks after, functional result good.
14. Debrie, E. J. Lyon Médical, 1905, vol. 105, p. 369.	Male, 19 yrs.	A series of traumatisms on Nov. 26, horse-kick on thigh directly above patella. On Dec. 26, in effort to maintain his equilibrium, fell backwards. Joint effusion; limb absolutely impotent. On Jan. 14, fell; symptoms of ruptured quadriceps tendon were manifest.	Flap with convexity downward. Suture of tendon with twelve catgut sutures.	Recovery. Good result.

The following table shows the symptomatic resemblance existing between these three conditions:

Complete rupture of quadriceps extensor femoris tendon. (See Table III.)	Complete rupture of the ligamentum patellæ. (Table IV.)	Complete transverse fracture of the patella.
1. May be bilateral. (Cases 8, 9.)	do.	do.
2. More common in males. 13 cases. All males.	do. Cases 2, 3, 4, 5, 6, 7, 9, 10, 11.	do.
3. May be due to direct (cases 2, 6, 7,), to indirect violence, to muscular action, or to a combination of two or of all of these different forms of violence. It is frequently stated that the disabling lesion occurred during an effort on the part of the individual to avoid a fall. (Case 9.) Quénu says that in the great majority of cases, rupture occurs during a contraction of the quadriceps extensior initiated to avoid flexion of leg on thigh.	do., do.	do. do.
4. Inability to extend leg on thigh. Patient is unable to elevate heel from surface of bed.	do. Cases 2, 3, 4, 6, 7, 9, 10, 11. do.	do. do.
5. Distinct sulcus can be felt between the margins of proximal and distal portions of the divided tendon. (Cases 2, 4, 5, 7.)	Distinct sulcus can be felt between the margins of the proximal and distal portions of divided ligament. (Cases 1, 2, 3, 4, 6, 10, 11.)	Distinct sulcus can be felt between fragments of the fractured patella.
6. Flexion increases, extension lessens, width of sulcus.	do.	do.
7. May be open (case 7) or subcutaneous.	do. Open, 11.	do.
8. Joint involvement frequent. (Cases 2, 6, 7, 11.) "Out of 21 cases treated operatively, in ten the joint capsule was found opened." (Walker, 10.) If the site of rupture be at or near the patellar attachment of the tendon, the knee-joint is usually opened, owing to the anatomical relations of the latter.	More frequent. Cases 1, 11. "In 20 cases of ruptured lig. patellæ treated operatively, Walker, 10, states that the joint capsule was involved in 12 cases.	Almost constant. do.
9. Open operation gives by far the best results. "Out of 21 cases treated by the open operative previous to 1896, 19 made a complete recovery." Walker, 10. Since then, the results of operative treatment have improved.	do. In 23 cases treated non-operatively, the recovery was complete in only several (Binet, 10½). "Out of 20 cases treated by the open method previous to 1896, complete recovery followed in 16." 10. do.	do. It is the treatment of election.

Let us briefly consider the complete pathological and traumatic ruptures of the quadri-

TABLE IV—TRAUMATIC RUPTURE OF THE LIGAMENTUM PATELLÆ

1. Tietze. Monatschrift für Unfallheilkunde, 1899, p. 212.		In falling backward ruptured ligamentum patella. Right patella was 2 cm. higher than left. Distinct sulcus immediately beneath patella. Extension of leg impossible.	Convex downward incision. It was seen that joint capsule was torn on both sides of patella. Margins of torn tissues curled up. Suture of ligament patellæ and of joint capsule with silk stitches.	Perfect functional recovery.
2. Pendl, Wiener. Klin. Woch.,1901, Band. 14, p. 549 Ein Fall von subcuta Zerreissung des Lig. Patellæ. Poprium.	Male, 42 yrs.	Ruptured ligamentum patellæ in effort to save himself from fall. Left patella 2 cm. higher than right patella. Depression in course of lig. patellæ in which a finger can be laid. Active extension impossible.	Longitudinal incision 12 cm. long. Exposed divided ends of ligament and with 8 silk sutures, sutured them to each other. At time of exposure, the ends of the lig. were curled upon themselves. Spontaneous healing could not have occurred.	8 weeks after, function nearly normal. 4 mos. after completely normal. Two bony nodules developed in the substance ligament.
3. Blauel, C. Beiträge z. Klin. Chirurgie, 1901, vol. 29, p, 450. 2 cases.	20 yrs.	Fell upon right knee. Almost total inability to extend limb. Rupture of ligamentum patellæ. Subcutaneous rupture. Ligament torn off from patella. Capsule and fasciæ were torn.	Exposure of laceration. Catgut suture.	At end of 69 days, very good results. Later reruptured lig. Operation refused. Bad result.
	Male, 56 yrs.	Ligament ruptured subcutaneously near anetrior tibial tubercle. Complete extensor-paralysis. Patella displaced 3 cm. upwards. Distinct sulcus. Active extension of leg on thigh is absolutely impossible.	Sutured with 2 silver stitches. Prepatellar bursa which had been torn by accident, was sutured.	Good result. The ligament became ossified There was no interference with function.
4. Riegner, Allg. Med. Zentralztg., 1901, vol. 70, p. 31.	Male, 48 yrs.	In jumping from street car, fell. Could not extend limb. Patella drawn upward. Groove in lig. patellæ.	Lig. patellæ was torn in its middle. Longitudinal incision 12 cm. long. Simple suture. No drainage.	Complete recovery.
5. Hopkins, Barton. Ann. of Surgery, 1903, vol. 37, p. 460. Rupture of ligamentum patellæ.		Muscular violence. Patella was found to be drawn up the thigh, at least 5 inches above its normal position.	Operation a few hours after accident. Patella was found to be entirely denuded of its periosteum.	Functional restoration complete.
6. Zunmermann. Der Militärärzt. Wien. 1903, vol. 37, p. 84.	Male, 39 yrs.	Fell on right knee. Subcutaneous rupture of ligament patellæ. Right patella two fingers' breadth higher than left. Could not extend leg. Locomotion impossible. Hæmorrhagic extravasation in joint.	Ligament ruptured in its center. Sutured capsular rents. Evened up the torn margins of the ligament and sutured them with silk.	Excellent functional recovery. Knee was as good as other.
7. Ross, Geo. C. Annals of Surgery, 1904, vol. 39, p. 603. Rupture of the Ligamentum Patellæ.	Male, 40 yrs.	Fell in kneeling position. Legs being flexed on the thigh and thigh on the body. Rupture of lig. patellæ ½ in. below lower border of patella. Loss of extension. Separation of 2 in. between divided ends.	Torn fringed ends of patella ligament trimmed and united by kangaroo tendon.	Patient has fair functionating joint.
8. Delbet, Paul. Bull. et Mém. de la Société Anatomique, de Paris, 1905, vol. 7, p. 910. Rupture du ligament rotulien.		Rupture of lig. patellæ. The line of the tear corresponded to the outline of an inverted M. A medium bundle of fibres had been torn off the tip of patella. Two lateral bundles were detached from the tibia, having pulled off splinters of bone.	Suture.	Total functional cure.

TABLE IV — Continued

9. Ombredanne, L. Rev. d'Orthopédie, Paris, 1906, and ser., vol. 7, p. 107.	Boy, 19 yrs.	Fell upon both knees. Ruptured left ligamentum patellæ. It was impossible for patient to raise his heel from the surface of the bed. Ascent of the patella of 2 cm. Operation 5½ months after first rupture. Good result. About two months after first operation, re-rupture.	Operation 5 weeks after second accident. U-shaped incision. Transverse perforation of the base of the ant. tibial tubercle. Also perforated transversely the patella through the horizontal diameter. Passed a silver wire through these two perforations and knotted it 2 cm. below perforated shin of tibia. Passed a silver wire through this opening, which silver wire was also passed through the tendon of the quadriceps in such a way as to surround the superior half of the circumference of the patella. The ligament patellæ was re-united with catgut.	Excellent functional result. Follows his occupation, that of barber.
10. Ranzi, E. Archiv. für klinische Chirurgie, vol. 80, 1906. p. 567. Beiträge zur operativen Behandlung von Fracturen. Case 1.	Physician, 41 yrs.	Ligamentum P. was ruptured just beneath the patella. Extension impossible. Transverse sulcus easily palpable.	Operation one month after injury. Crucial incision. Margins of ligament united with silk. 17 days after operation, careful active motion permitted.	Flexion and extension fairly good.
Case 2.	Male, 33 yrs.	Extension of leg impossible. Patella displaced upwards. Joint swollen.	Operation 6 days after injury. Convex incision Suture of torn ligament.	Restoration of function normal.
Case 3.	Male, 31 yrs.	Fell from a bicycle against a tree. Unable to arise. Patella is intact and displaced upward. Flexion and extension impossible.	Operation 5 days after injury. Crucial incision. Thickest portion of Ligament patellæ torn. The medial parapatellar ligament was also torn. Crucial incision. Suture of torn tissues.	Complete restoration of function.
11. Painter, C. P. Bost. M. & Surg. Jour., 1908, vol. 158, p. 930. Case 1.	Male, 23 yrs.	Cut with an axe. Voluntary extension not possible. X-ray did not show conclusive evidence of section of patellar tendon. Atrophy of thigh, atrophy of calf. Passive motion of knee-joint practically unrestricted.	Operation. 4 months after. Ether. Vertical incision, 9 cm. long directly over patellar tendon. A net-work of silk was passed to and from the insertion of the tendon into the tibial tubercle underneath the tendon itself and again sub-periosteally into the base of the patella in the form of a mattress suture. Sheath of tendon closed with silk sutures.	Patient has walked 10 miles without any discomfort. No appreciable impairment of function.
Case 2.	Male, 63 yrs.	Patient slipped, falling heavily with his knee flexed to a right angle. Unable to get up. Palpable hiatus below the lower border of patella. Considerable amount of clotted blood in articulation.	Vertical incision. Irrigated joint. Four holes bored in cartilaginous margin of patella, through which sutures were passed. These sutured were also passed through the ligamentum patellæ approximating both of these structures.	Function of limb entirely satisfactory.
Case 3.	Male, 32 yrs.	Five months previously fell from a car, striking heavily on the ground. It was supposed that he had fractured the patella. A marked hiatus felt below the inferior border of the patella. No bone could be palpated below the hiatus. An X-ray taken showed patella to be intact. Patient could not extend leg voluntarily.	Sutures passed through the cartilaginous margin of the patella and quilted into the patellar tendon.	Good functional recovery. He could go up and down stairs in a normal manner.
12. McQuestion, C. A Pacific Med. Journal, 1903. vol. 46, p. 403. Notes on a Case of Fra,-tured Patella occurring subsequent to separation, and repair of Ligamentum Patella.	Male, 84 yrs.	Fall from step; ruptured ligamentum patella.	Operation, 5 hours after accident. Semi-lunar incision. Wound flushed with normal salt solution. Drilled 3 holes through the superior border of the patella, through which three sutures were passed. These sutures were also passed through the ligamentum patellæ. Immobilization six weeks.	Two months later, patient fell. He sustained a transverse fracture of superior border of patella of same limb. The bone was fractured, but the ligamentum patellæ remained intact.

ceps extensor femoris tendon. We do this because in these ruptures, the form of treatment which is productive of the best results, which most frequently secures the best functional recovery, and the most accurate anatomical restoration of the parts, is that which we urge for most fractures of the patella; viz., the open operative treatment.

The quadriceps extensor tendon may be ruptured at any part of its course. If the site of rupture be at or near the patellar attachment, the knee-joint is very liable to be involved. Ruptures, open or subcutaneous, of the quadriceps extensor femoris tendon, when complete, entail very definite symptoms. This muscle and its tendon, in conjunction with the patella and the ligamentum patellæ, constitute the main extensor apparatus of the leg. Complete division of the tendon entails loss of the power of extension of the leg upon the thigh. Table III, cases 2, 5, 6, 7, 8. In 1896, Walker (10) analyzed with special reference to treatment and to the results of same, 255 cases of rupture of the quadriceps extensor muscle and of its tendon above and below the patella. 140 of these cases of rupture occurred below the patella; 115 cases occurred above the patella.

Quénu and Duval (11) collected, from the literature, 19 cases of rupture of the quadriceps extensor tendon, operatively treated. To these, they added three unpublished personal cases. Out of these 22 cases, all treated at different periods by the open method, by surgeons of different countries, there were 21 good results and one not wholly satisfactory result. They conclude that the operative treatment, in these cases, has no mortality, and that it is the rational treatment of complete ruptures, whether open or subcutaneous, of the quadriceps extensor femoris tendon. Previous to approximating the divided ends of the tendon, intra-articular and extra-articular blood extravasates and exudates should be removed.

Hoping that they may prove of some interest to the reader, we, herewith, append a few cases not included in the Quénu and Duval's article. In all of them, the open operative treatment was employed; the results were very satisfactory.

RUPTURES OF THE LIGAMENTUM PATELLÆ

Ninety-one per cent of all of the reported cases of rupture of the ligamentum patellæ have occurred in males. It would seem that old fractures of the patella predispose to this accident. In 140 cases, this etiological factor was present 17 times (12). As in the case (12) reported by Ombredanne, whose patient fell upon a broken glass bottle, thereby rupturing his ligamentum patellæ, ligamentary ruptures may be associated with wounds of the overlying tissues. Muscular action may be, in the subcutaneous forms, the exclusive factor in the production of the lesion; it may be the main factor acting in conjunction with predisposing and other contributory factors. After complete ruptures of the ligaments, the distal portion retracts, at first by virtue of its elasticity, later owing to cicatricial contraction.

Many clinicians are of the opinion that, when aseptically practiced, suture of the torn ligamentum patellæ invariably gives good results. Ombredanne is an exception to the rule. He believes that a complete rupture of the ligamentum patellæ is best treated as follows: a silver wire ligature is made to traverse horizontally the patella above and the anterior tibial tubercle below, and then tied. Then about 2 cm. below the anterior tibial tubercle, the shin is perforated. A silver wire is passed through this opening and guided and passed in the substance of the quadriceps tendon, in such a way as to surround the superior half of the circumference of the patella. He thus has in addition to the interosseous suture, an inter-osteo-tendinous suture. Support is further supplemented by a careful coaptation by catgut sutures, of the torn or divided margins of the ligamentum patellæ. Of 27 cases collected by Norris, in which the ruptured tendon was sutured, there were 27 complete cures.

In the medical literature very few cases of ruptured ligamentum patellæ are to be found reported. I have tabulated the few cases that have been published since 1899, in the French, English, and German medical literature, to which I have had access.

The quadriceps extensor femoris muscle, the patella, and the ligamentum patellæ are the main structures by which extension of the leg on the thigh is effected. The integrity of

each of the main constituent parts of this extensor apparatus is indispensable for the proper performance of the functions of the knee-joint. The restoration of the continuity of a completely fractured patella is just as essential for anatomical and functional recovery of the affected extremity as is that of a completely divided quadriceps extensor femoris tendon or that of a completely torn ligamentum patellæ. The careful approximation of the divided ends of the quadriceps extensor femoris tendon, the exact coaptation of the separated ends of the torn ligamentum patellæ can be done effectively only by the aid of sight, that is, through an open operation. The same applies to the fractured patella, the exact apposition of the fractured surfaces of whose fragments is frequently prevented by obstacles removable only by an open operation. The ideal function only exists when each and all of the aforementioned elements are anatomically and functionally absolutely normal. The study of the previously discussed conditions was undertaken to determine whether or not in the absence of any single one of these elements or in the presence of a pathological state of any single one of these elements, vicarious compensation on the part of the other occurred. It led to the conclusion that perfect function presupposes and demands anatomical integrity.

FRACTURES OF THE PATELLA

The patella is the largest sesamoid bone in the body. Its outline and anterior surface are accessible to palpation. The different dimensions of this bone are said to be $1\frac{3}{4}$ inches in length, $1\frac{5}{8}$ inches in width, by $\frac{3}{4}$ of an inch in thickness. Needless to say that it varies in size in different persons, being better adapted to perform its functions in one than in another. It is developed and imbedded in the substance of the largest and most powerful muscle group in the body, the quadriceps extensor femoris muscle, and therefore forms a part of the extensor apparatus of the knee. Any portion of the patella, base, body, apex, and borders may be the seat of fracture. It is well to keep in mind that fractures of this bone are almost invariably intra-articular, that is, the line of fracture almost always extends into the knee-joint, thereby involving the largest and most complex synovial cavity of the body. This fact is important from the symptomatic, therapeutic, and prognostic standpoints.

Fractures of the patella, according to Von Bruns, to Rossi, represent one and four-tenths percentum of all fractures. Mueller (13) out of 1,000 fractures treated at his clinic, had fifteen fractures of the patella. At the Cook County Hospital (Chicago), from January 1, 1903, to June 30, 1908, inclusive, there were treated 5,650 fractures; of these, 136 were fractures of the patella. From May 25, 1864, to December 31, 1905, inclusive, 38,627 fractures of all kinds were admitted to the Boston City Hospital; 692 were fractures of the knee-cap (Scannell, 14).

Fractures of the patella possess the characteristics common to all fractures. They may be subcutaneous; they may be open; in our tables, 21 compound fractures are included, cases $6\frac{1}{2}$, $10\frac{1}{2}p$, 17, 23, 25, 33, 53, 57, 59, 63*a*, 92 (2 cases), 95*a*, 99, 101, 111, 123 (2 cases); may be complete or incomplete; may be unilateral or bilateral (13*b*). The right and left patella seem to be each involved with about equal frequency. (In the cases collected at the end of the article, the knee involved is stated 71 times; right patella 37 times; the left patella 34 times.) If the fracture be bilateral, both bones may be fractured simultaneously, cases $10\frac{1}{2}e$, 22*m*, 44, 57 (2 cases), 59, 62*a*, 73*b*, 97 (2 cases) or in succession, that is, an interval of time of greater or less duration intervening between the two distinct fractures (cases 6, $10\frac{1}{2}m$, 52, 62*b*, 90, $96\frac{1}{2}$, 115, 124). The time that intervened between the fracture of one patella and the solution of continuity in the other is recorded under the indications (No. 2) for operative treatment.

Fractures of the patella may be simple, may be complicated by significant injuries of the neighboring structures or tissues. In 48 out of 55 cases reported by Boeckenheimer (cases 110) an injury of the accessory patellar ligaments, or reserve extensor apparatus, was present. In case 6, the external lateral ligament of the knee-joint was completely severed. In case 25, the anterior cartilage of the femoral condyles was scooped off as by a gouge. In case 99, the external condyle was completely detached. In case 74*a*, in addition to the frac-

ture of the patella, there was a simple fracture of the femur of the same side, and on the opposite side both the tibia and the femur were fractured. In case 33, the quadriceps extensor femoris muscle above and the ligamentum patellæ below were extensively lacerated. In two cases (108*a* and *d*) there was a coincident complete rupture of the ligamentum patellæ. These fractures may be recent, may be old. We will consider, somewhat arbitrarily, we acknowledge, as old fractures, all those that are of more than two months' standing. The following old fractures figure in our tables:

Case 1. Nine months' standing.
Case 9. Five years.
Case 10. Four years.
Case 11. Six months.
Case 14. Four months.
Case 22*a*. Five months.
Case 22*m*. Six months.
Case 26. One year.
Case 35. Six months.
Case 37. Two months.
Case 54. Time not stated (10 cases)
Case 57. Time not stated (6 cases).
Case 72. Two months, three days.
Case 75. Several months.
Case 62*c*. Time not stated.
Case 65*b*. Four months.
Case 109. Two months.
Case 115. Two years.
Case 124. Six months.

The determination of these different types of fractures is, from the operative and from the prognostic standpoints, of great importance. For instance, in old fractures, the fractured surfaces must be freshened and the interfragmentary fibrous band resected. Compound fractures call for immediate operation. Comminuted fractures may call for removal from the articular cavity of detached bony fragments.

These fractures may be due to violence, direct or indirect, or to muscular action. It is not uncommon for two or all of these factors to be associated in the production of the injury. All the compound fractures included in our tables were due to direct violence; a blow, a fall, a kick, etc., upon the knee-cap. If direct violence be the causative factor, the greater the violence — the greater the likelihood of stellation, of comminution of the bone.

Some clinicians classify these fractures into (*a*) blow fractures, (*b*) tear fractures, and (*c*) such as are due to a combination of both factors, impact and traction. From an etiological standpoint, this classification is of value, but it cannot be utilized as a constant guide to determine whether operative or non-operative treatment is indicated. In the tear fractures, the lateral expansions of the quadriceps extensor muscle on either side of the patella are torn, and, almost always, there is considerable separation of the fragments of the fractured bone. Tear fractures have been reported in which separation (detectable by inspection and palpation) of the fragments was not present (15). Such cases are of very exceptional occurrence. Blow fractures have been reported in which marked separation of the fragments was found to be present. The surgeons have stated how, in some of the reported cases, the injury occurred. We assume that when the fracture follows a fall upon the knee, that the causative factor is direct violence. The statements as to cause resume themselves as follows (naturally, we base ourselves on the reports of the observers). In 183 cases it is plainly stated that the fracture was due to direct violence; in three cases, the reporters state that "the cause was indirect violence."

We find reported such statements of the circumstances surrounding the accident as the following: While making an effort to regain his balance, to restrain himself from falling, the patient fractured his patella (cases 4, 27*a*). In case 10½*b*, it is stated that the patient slipped in a room, then fell in a sitting position, a fracture resulted; case 10½*m*, patient missed a kick at a dog, a fracture followed. Case 22*k*, patient in falling upon her back, heard a cracking sound in right knee. Case 40, an intoxicated individual fell down 10 or 12 steps backward. Case 44, both patellæ snapped, as patient was endeavoring not to fall. Case 46, patient fell and in attempting to regain his balance, felt something crack in his knee. Case 47, patient ran into an obstacle, and, in falling backward, fractured his patella. Case 49*a*, in an attempt to restrain a fall, patella fractured. Case 63*b*, patient refractured his patella while lifting a heavy load. This also occurred in case 120. In case 108*a*, it is distinctly stated that the patient heard a crack in her right knee before hitting the

steps upon which she fell. In case 108*b*, patient lost his balance and fell backward while sparring. Oehlecker (105) reports a case of fractured patella that occurred as follows: Patient received a blow upon the front of the chest; he made an unsuccessful effort to retain his balance, heard something crack in his knee, and then fell backward. In case 112, the patella was first fractured, apparently, into two fragments by muscular action, then by a violent fall on the ground, the lower of the fragments was smashed into five pieces. In 57 other cases, it is also stated specifically that the fracture was determined by muscular action. Schmidt (Table, No. 102) has classified his cases into tear and blow fractures, giving a total of three blow fractures, 8 tear fractures, and 20 due to both blow and tear. In the remaining cases which appear in our tables, the cause of the fracture is either not specified or is stated ambiguously. For instance, in case 63*d*, it is stated that the patient fell from a tree and his knee flexed under him. Was the fracture in this case due to impact on the patella or to traction exerted by opposing forces upon this bone, the quadriceps extensor, and the ligamentum patellæ? In such cases we make no attempt to determine the cause of the fracture, or rather we do not express what in our opinion appears to have been the cause of the fracture. (For Table, see p. 225.)

INCIDENCE AS TO AGE AND SEX

The authors reported the sex of the injured patients in 447 cases. Out of this total, 388 of these fractures occurred in males, and 59 occurred in females.

Fractures of the patella are infrequent in childhood, and in adolescence. Incidence as to age is specifically mentioned in 232 cases, divisible as follows:

Age is stated, sex is not stated, in George Schmidt, cases 102.

YEARS	CASES
0–10	0
11–20	2
21–30	7
31–40	18
41–50	12
51–60	9
61–70	3

In the other cases which appear in our tables:

MALES

0–10	1
11–20	5
21–30	47
31–40	27
41–50	57
51–60	26
61–70	10
71–80	2
81–90	1

FEMALES

0–10	0
11–20	2
21–30	5
31–40	6
41–50	2
51–60	1

In combining these tables we have the following totals:

YEARS	CASES
0–10	1
11–20	9
21–30	59
31–40	51
41–50	71
51–60	36
61–70	13
71–80	2
81–83	1

The youngest patient was a male 10 years old. His fracture was compound. He recovered only limited motion (case 123). Case 111*a* was a girl 14 years old. Her fracture was also compound. Cases 10½*e*, 64, were fifteen years of age. They were all subcutaneous fractures. Case 74*a*, a compound fracture, was a boy 15 years old. Case 11, a female, case 63, a male, case 86*a* (male), case 86*b* (2 cases), were closed fractures of the patella occurring in individuals 18 years of age. The oldest patient was 83 years of age (case 60). In case 27, the patient was 70 years old. Trendelenburg (case 113) reports a case occurring in an individual 71 years of age. In 65*e*, patient was 73 years old. Osseous union was obtained in all the cases mentioned in this paragraph; in one case it was verified at the necropsy; in the other cases, it was either verified by X-rays or inferred by the complete restoration of function and of anatomical contour obtained.

THE LINE OF FRACTURE

The line of fracture may be longitudinal, oblique, transverse, stellated. Comminution is not infrequent. Avulsion of tip, case 42, and of margin of base is reported. In case 46, the part torn off was the lower half-inch of the apex patellæ. Meyer (16) reports some longitudinal fractures; the diagnosis of which was verified by the Roentgen-rays; some were due to direct violence, others, to indirect violence.

In case 104 (a unique case, as far as I have been able to determine), the patella was fractured longitudinally in a frontal plane into two fragments. The fragment including the articular cartilaginous surface was hooked by its outer margin upon the external condyle. The fragment including the anterior convex part of the bone was maintained approximately in its normal position by the quadriceps femoris muscle. In the appended tables it is stated that the line of fracture was longitudinal in 3 cases (92, 104, 123); oblique, 8 times; approximately transverse, 166 times. Six stellated fractures are recorded. In 22 cases, comminution was present.

The fragments may be equal (rare) or unequal in volume.

The bone may be broken into 2, 3, 4, or more fragments. In 15 cases, there were 3 fragments; in cases 13, 50, 86, there were 5 fragments; in cases 34, 112, 6 fragments were present; in cases 10½*b*, 10½*h*, 17, 101, 126, each presented 7 fragments; in case 28, there were 8 fragments. In case 33, the bone had been fractured into 9 fragments. In some cases the expression "many fragments were present" is used (54, and others).

HÆMORRHAGE

In 223 cases, special mention is made of the coexisting, intra-articular hæmorrhage. The præpatellar bursa may be the seat of an hæmorrhagic extravasate. This more frequently occurs in the fractures due to direct violence.

INTERFRAGMENTARY SOFT TISSUES

Owing to the fact that the elasticity of the soft tissues exceeds the cohesion of the bone, in tear fractures (those that are due to the overaction of the quadriceps extensor muscle or to the exaggerated traction of the ligamentum patellæ), the soft tissues do not yield at the same level as the bone. The bony fragments may be separated as much as 2 cm. before rupture of the overlying soft tissues occurs. (The tear in the præpatellar fibrous tissues may be above, or may be below the line of fracture.) In case 96*c*, the aponeurosis was torn below the level of the line of fracture. These soft tissues may overlap, partially, or completely, one or both fractured surfaces. This fibroperiosteal curtain is not present in those cases, (they are few in number) of fractures of the patella in which there has not occurred a coincident rupture of the præpatellar ligamentous and fibrous tissue. The importance of this laceration of the soft tissues will be discussed later.

In reference to the interposition of this fibroperiosteal curtain between the fractured surfaces, Warbasse (57), who reports 34 cases makes this statement: "The torn periosteal tissue which had fallen between the torn fragments was trimmed away." Charles Phelps (60) says that in his cases, the absence between the osseous fragments of an interposed fibroperiosteal curtain was a very unusual occurrence. He reports 118 cases.

Lucas-Championnière (87), in reporting 70 cases, says that in a large proportion of them, a large flap of fibrous tissues coming from the anterior surface of the patella was interposed between the fragments. Barlöcher (92) in reporting 28 cases, says that in every one of his cases, it was seen at the time of operation that the fractured surfaces were covered by interposing soft parts which, had subcutaneous suture or non-operative treatment been employed, would have prevented osseous union. In 55 other cases, mention is made by the reporters of this fibroperiosteal fringe.

In complete fractures of the patella, the separation existing between the fragments may be slight, may be marked. It is always increased by flexion of the leg on the thigh. The capsular tears, the lacerations of the reserve extensor apparatus, play an important role in this fragmentary diastasis. In 128 of our cases, this interval was noted and recorded. In cases 27*e*, 28, 14, 46, the separation between the fragments was three fingers' breadth. In case 90*c*, the interfragmentary space was 2½

inches in width. In 9 cases, the fragments were 12 cm. apart. In case 11, the fragments were 4 inches apart.

Another symptom frequently noted is loss of the power of extending the leg on the thigh. Thus in case 4, we find noted, "Limb useless"; in case 9, "Functional disturbance similar to that of paralysis of quadriceps extensor muscle"; in case 11, "Power to extend knee was absent"; in case 14, "Absolute loss of function"; in case 18, "Absolute impotency of limb"; in case 35, "Impossible to extend lower limb"; in case 43, "There was immediate disability"; in case 115, "There was absolute extensor paralysis"; etc., etc.

REFRACTURE OF THE PATELLA

The patella is not uncommonly the seat of refracture. This accident is more frequent in the first few months following the original accident. It may occur later, especially when flexion has remained limited. Among the causes of refracture may be mentioned:

1. Situation of the patella over a functionally active joint.
2. Atrophic condition of the bone.
3. Adhesion, as a sequel of the previous fracture, of the patella to the femur.
4. Forcible flexion of the knee, as by a fall, beyond the range of motion that has been acquired. It has occasionally been caused by the surgeon in an attempt to forcibly increase by passive motion, the flexibility of the knee. Case 68*b*.

Either the bone itself, or the fibrous union, may be severed, that is, the fracture may be above the bond of union, may be below the bond of union, may be through the bond of union. Refractures are frequently indirect fractures in which the extensor apparatus yields at its weakest point, between the fragments, that is, at the ligamentous bond of union.

Rémy (17) reports two cases occurring in different individuals, in which the same patella was fractured twice in succession. In these two cases, the refracture did not occur at the site of the former fracture, but at a new site. In one of the patients, both fractures were due to muscular action; in the other, the first fracture was determined by muscular action; the second, by direct violence. Henry (18) reports a case in which two distinct fractures of the same patella occurred within 8 months. The skiagram taken showed that there had been two fractures distinct one from the other. Refractures of the patella (the same applies to other fractures of the patella) may be simulated either by complete ruptures of the quadriceps femoris tendon or by ruptures of the ligamentum patellæ. Either of the two latter conditions may have been preceded by a fracture of the patella, as in the case reported by Murray (19). In this case, the patient, six months after having sustained a fracture of the patella, fell on the same knee. Neither the newly formed callus nor the patella gave way, but the ligamentum patellæ was torn loose.

Under cases 57, two refractures of previously wired patellæ are reported. In one, the fracture was at the old line of union; the wires had broken at the place of twisting; in the other, the fracture was at a new site, the old line of union being perfectly solid. One wire was found broken and the other had torn out of the bone. In case 76, the refracture was at a higher level than the former fracture. In cases 63*b*, and 90*b*, the fibrous band uniting the fragments was the seat of the solution of continuity.

In cases 75 and 102, the patella was twice refractured. In cases 60 (4 cases), at the second operation it was seen that the previous fracture had healed by osseous union.

In one of Bockenheimer's cases (110), the refracture occurred six weeks after wiring; in the other, 10 years after wiring. In case 74, one refracture occurred 5 years after the first fracture; the second refracture, six weeks after wiring of the patella. In case 27*e*, the refracture occurred 26 years after the first fracture.

Pilcher (127) presented to the Brooklyn Surgical Society cases of fractured patellæ that had been treated operatively with success. At the same time, he showed some skiagrams. One of the latter demonstrated a patella with two different healed fractures. In this patella, the fractures were at different sites. In case 130, at the time of operation it was seen that the refracture was at the same place as the previous fracture.

There figure, in our tables, 14 cases of refractured patella, the first fracture of which was treated non-operatively, and 15 cases of refracture occurring in patellæ whose first fracture had been treated operatively.

TREATMENT

In fractures of the patella, the following indications have to be met:

1. The fracture must be reduced.
2. The bony fragments must be maintained in intimate apposition until organic union has been effected.
3. The continuity of the divided soft tissues must be re-established.
4. The functional integrity of the knee-joint must be restored.

The value of any form of treatment is dependent upon its ability to meet the above indications. All forms of treatment can be classified into one or the other of two main classes: The non-operative and the operative. The latter admits of further subdivision into the subcutaneous and open methods.

It is evident, that in each individual case, the adoption or rejection of any form of treatment is to be determined largely by the nature, the type of fracture at hand. Each method has advantages and disadvantages; indications and limitations.

The numerous non-operative methods of treatment that have been employed; the large number of percutaneous and subcutaneous operations for approximation of the fragments, that have been proposed, lauded, tried, and then abandoned; the comparatively great number of patients, who, having been subjected to non-operative treatment, of themselves seek operative treatment in order to lessen or entirely overcome their disability, all these are proofs that all the non-operative, and the subcutaneous operative methods as well, have deficiencies which debar them from ever being elective methods of treatment.

Occasional cases are to be found in the literture of the subject, in which, though the operator succeeded in restoring to the patella its normal anatomical contour, functional integrity of the knee-joint was not secured. Our explanation for these cases is that some essential step in the operation has either been completely overlooked or unskillfully performed, or that the post-operative treatment has been injudicious. The extravasated blood may not have been removed from the synovial cavity; the lacerations of the soft tissue may not have been repaired, etc.

A distinction must be made between the shortcomings of the operator and the shortcomings of an operative procedure, as such.

A few, a very few, cases, such as the following, can be found in the literature.

Sonnenberg (21), showed two patients, who, despite a separation of from three to four inches between the fragments of their fractured patellæ and noticeable atrophy of the quadriceps extensor femoris had fairly good function of the limb. In one of these, the bone was in three fragments, owing to a twice fractured patella. An explanation of these exceptional cases is to be found in the fact that the reserve extensor apparatus of the leg either was not injured, or if injured, that its integrity was restored, and thereby the loss of continuity of the patella is fairly well compensated. Though in isolated cases, good functional results may follow non-operative treatment of fractures of the patella, as a rule, its employment is followed by very unsatisfactory results. Facts confirm what logic had led us to expect. Anatomical and functional integrity go hand in hand. In the treatment of fractures of the patella, we have come to discard all the subcutaneous and percutaneous operations. In scientific conception and in the practical results obtained by their employment, the inferiority of the various subcutaneous methods to the various open operations is manifest. We acknowledge that under exceptional circumstances, the operator may feel compelled to resort to them. The best known are Ceci's, Kocher's, Barker's, and Butcher's operations. Ceci's operation consists in subcutaneously drilling the fragments and inserting the approximating wire in a figure of eight pattern. Butcher's, Barker's or Kocher's methods consist of passing approximating metallic or non-metallic ligatures around or over all the fragments.

Why do we advise the abandonment of the various subcutaneous and percutaneous operations? Because:

1. They do not enable the surgeon to accurately coapt the fractured fragments. After an arthrotomy, either by bone suturing, by circumferential looping or ligaturing, or by careful sewing of the torn soft tissues, the fragments can be closely apposed and held immovably together. This intimate apposition of the fractured surfaces lessens the liability to an excess, either in length or in width, of callus formation. Any change in the contour of the patella is liable to interfere with the normal adaptation of its articular surface to the femoral articular surface.

2. They do not enable the operator to freshen the fractured surfaces. In the repair of old fractures, the resection of the interfragmentary fibrous bond of union, the freshening of the fractured surfaces, are among the essential steps of the operation.

3. They do not insure against union of the bony fragments in a faulty position. Impaired function results from union in a faulty position. The open operation enables the surgeon to overcome any tilting of fragments, as well as any tendency to union in faulty position.

4. The subcutaneous methods make no provision for the toilet of the synovial cavity. The open operation allows of the early and complete removal of all articular effusions, of all extravasated blood, intra- or extra-articular, liquid or clotted, of all completely detached bone fragments. In cases 10½*e*, 19, 50, 53, 54, 80, 81, 101, it is stated that detached bony fragments were removed either from the articular cavity or from the contiguous tissues.

5. The tears in the capsule, the lacerations in the aponeurotic expansions of the vasti, demand repair. Only by means of an open operation can they be repaired. The extensor apparatus of the leg must be considered as one organ. Structural impairment of any of its constituent parts entails a corresponding impairment of function. The insertion of the vastus externus and of the vastus internus into the capsule of the knee-joint and the lateral prolongations of their insertions down upon the head of the tibia and fibula are of assistance in the extension of the leg on the thigh. Solutions of continuity in these tissues must be repaired.

6. None of the subcutaneous operations allow of the removal of the fibroperiosteal shreds which so frequently overlap the fractured surfaces and which in some cases have been found to adhere so tightly to bony projections that for their liberation it was necessary to use forceps and curette. These fibroperiosteal shreds are an obstacle to osseous union; they can be removed by an open operation.

7. The subcutaneous and percutaneous operations create openings which are inadequate for the escape of intra-articular and extra-articular extravasates and exudates, but which are ample for the introduction of infection.

Before proceeding, let us determine the dangers, their nature and their gravity, to which patients are exposed by the employment of the open operative treatment. Powers (19*a*) collected and published in 1898, a list of 711 cases of fractured patellæ. All had been treated by the open operative treatment. In his series, three deaths occurred. They were due to sepsis. In the same year, Phelps (22), collected 420 cases of these fractures that had been treated by the open operative method. This series also contained three deaths; one due to carbolic acid poisoning; the other two to delirium tremens. N. P. Trinkler (20) in 1899) published the following summary of 216 cases:

		Total No.	Good Results	Osseous Union	Fibrous Union	Impaired Mobility	Ankylosis	Infection	Death
Antiseptic period, 1883–1890	Recent fracture.	96	67 69.6%	72 79.1%	5	6	2	4	2
	Ancient fracture.	11	8 72.7%	8 72.7%	3	2			2
Aseptic period, 1890–1898.	Recent fracture.	88	76 88%	80 90.9%	3	2		1	
	Ancient fracture.	21	18 87.1%	17 85.7%	1	1	1	1	

The probability of ankylosis, joint suppuration, or pyæmia following an aceptic arthrotomy, can almost be disregarded. In none of Mullin's cases (106), was there a rise of temperature worth mentioning. Stimson (cases 131) between the years 1892–1906 performed the open operation for fractured patellæ over 200 times. During this entire period, his only mishap was a slight suppuration, which caused no subsequent difficulty. We concede that the general dangers inherent to other major operative procedures are also present in these cases. These dangers, anæsthesia,

shock, and suppuration, are common to all operations. Shock can be minimized by rapid operating. The time consumed in the performance of any operation should be the shortest consistent with the careful and complete execution of the different steps of the operation. We will not, at this time, discuss the other two dangers.

Thiem (24) examined the official records for the years from 1895 to 1903, inclusive, of the German Workingmen's Indemnity Insurance Union. This is an official record and among the reporters are advocates and opponents of the open operative treatment. During this period, indemnity was paid for 283 patellar fractures; 223 of these were treated non-operatively; six deaths occurred; 60 cases were treated operatively, 2 deaths occurred. One of these deaths was from delirium tremens complicated by pneumonia; the other death was due to pyæmia consecutive to a suppurative arthritis.

In the 1,100 cases included in our tables, we note the following accidents. In 1898, in case 54, following operation on an old fracture, some inflammation of the periarticular tissues developed. It caused no permanent disturbance. In the same year, under cases 58, two cases of superficial suppuration and one case of suppurative arthritis are recorded. In the latter case, ankylosis resulted. In cases 60, also in 1898, 5 cases of ankylosis followed operative treatment. In 1902 (92) Barlöcher reports having had, after open operative treatment, one case of ankylosis and two deaths. One of these deaths was due to delirium tremens; the other one was due to pneumonia.

In 1903, Championnière (87) reported one case of suppurative arthritis subsequent to an open operation for fracture of the patella; ankylosis resulted. In 1903, Bockenheimer (110) reports one death from pulmonary embolism occurring after this operation. In the same year, Trendelenburg (113) reports a case in which after an arthrotomy performed to repair a fractured patella, ankylosis resulted. In 1905, Doberauer, (case 86*b*) had one death. Patient was in bad general condition. Rigby 117*a*, in the same year, reports case resulting in ankylosis, and another in which owing to infection and disorganization of knee-joint amputation of leg was performed. In 1906, in cases 126, one case of ankylosis, and in cases 132, 4 cases of ankylosis and one death from infection are reported. In case 123*a*, a compound fracture, patient at time of discharge had recovered 10 degrees of flexion. In cases 10½, there was in one case a mild post-operative superficial suppuration; one death from apoplexy is also reported in this series, giving us in 10 years 16 cases of ankylosis, 6 of which occurred either in or previous to the year 1898. Of the remaining 10 cases, 4 occurred in the hands of an operator, who, judging from his reports, has been unusually unfortunate with this operation. The 6 others occurred in the practice of enthusiastic advocates of the open operative treatment. (Rigby, Barlöcher, Championnière, Trendelenburg.) During the period covered by our tables, we have, occurring after this operation, six deaths. Three of these, in our opinion, cannot be attributed to the operation (delirium tremens, pneumonia, cases 92, apoplexy, case 10½*n*). In cases 110, one death was determined by pulmonary embolism. We must acknowledge two deaths, 86*b*, 132, from infection.

We believe we are fully justified in stating that the dangers of the open operation, if it be performed with due precaution by careful and skillful hands, are practically nil. There is always plenty of time to reach hands well able to perform the operation (30).

What are some of the advantages of the open operative method?

1. Refracture of the patella is more common after massage and other forms of non-operative treatment than after the open operative treatment. Alessandri (23*a*), Gibbon (23*b*–23*c*). Refracture is more frequent in the patella than in any other bone Lauper (23*d*). By more closely restoring the bone to perfection, the open operative treatment lessens to a considerable degree the tendency to refracture. Corner (23c) found in the St. Thomas Hospital (London) records for ten years, that out of a total of 254 cases of fractured patellæ, there had been 30 cases of refracture. Eleven of these occurred after operative treatment; 19 after non-operative treatment. Thiem (24), (Cottbus), states that in 223 non-operatively treated cases of fractured patellæ, 15 refractures occurred.

One of these patients in 18 years had 4 fractures of the same patella; another 3. In this last patient, the first two fractures were treated non-operatively. The last was treated by an open operation. It has never recurred. In 60 cases treated operatively, only one refracture occurred. This was operated; recovery ensued (24).

2. In any fracture, the union between the fractured fragments which is considered the most desirable, is osseous union. Modern surgeons do not expect to obtain osseous union in fractures of the patella which are treated non-operatively. Its occurrence under such conditions, though possible, is so rare that it is considered a pathological curiosity. One of the main justifications of the open operative treatment is the frequency with which osseous union follows its employment.

It was a long time denied, and, even up to recent years, was still doubted, by some of the best informed authorities, that bony union could occur after these fractures. Its occurrence can no longer be gainsaid, as it has been demonstrated in several non-operatively treated cases and in many of the operatively treated fractures.

In some of the cases that, many months after operation, came to direct inspection, the union, which was so close that no independent mobility of the fragments could be recognized, was found to be fibrous. Therefore, owing to the fact that clinically one can easily mistake a short fibrous union for an osseous union, the proofs that osseous union of fractured patellæ can occur and has occurred, in order to carry conviction, must be anatomical. Morestin (25) showed to the Soc. Anatomique de Paris, a patella which had been fractured several years previously. A long time after recovery from the fracture, which was treated non-operatively, the patient died from some cause independent of his previous knee-cap injury. The bond of union, in the patella, was osseous. This callus was 1 cm. in length, and occupied four-fifths of the transverse width of the patella. Owing to the presence of this callus, the patella that had been fractured exceeded in length its fellow by about 1 cm. Jowers, R. F. (26) demonstrated to the Brighton and Middlesex Medico Chirurgical Society, a patella which, 2½ years previous to the patient's death, he had wired for fracture. There was perfect bony union. Dreyfus (27) found, in a dissecting room subject, a patella which had been circumferentially looped. A silver wire imbedded in the substance of both quadriceps extensor tendon and the ligamentum patellæ surrounded the bone. This silver wire and a slight prominence at the former line of fracture, on both the internal and external borders of the patella, were the only traces of the injury which the bone had sustained. These lateral prominences were each the size of a split pea. The anterior half of the callus was osseous, the posterior half was fibrous. The anatomical integrity of the knee-joint was complete. The result in this case had been perfect from the physiological and almost perfect from the anatomical standpoint. The specimen was shown to the Société Anatomique de Paris.

Phelps (22) had the opportunity to examine the wired patella of two of his patients who had died some time after recovery from their fractures. In both patients, the formerly fractured patellæ showed undoubted ossific union. One of the patients, 83 years of age, had died from acute bronchitis one month after operation; the other from cerebral disease, seven months after the operation. In cases 60, reported by the same surgeon, at the time of operation of four refractures, it was seen that in all of them, ossific union had taken place at the primary site of fracture. Chiari (28) exhibited to the German Medical Society of Prague two patellæ which, for fracture, had been silver-wired in Wolfler's clinic, one, five years, the other, seven years previous to death. These two patellæ had been removed at autopsy. Upon section, they showed perfect osseous union. Doberauer (cases 86*a*) refers to these two cases and to two other cases (29), in which demonstrated osseous union followed wiring of fractured patellæ. The bony nature of the union was verified at autopsy. One, reported by Mahr, came from a patient who 21 days after the suture of his fractured patella, died from pulmonary embolism secondary to thrombosis of the femoral vein. The other, reported by Vallas, was that of a woman 65 years of age, who, five months after an open suture of a transverse

fracture of the patella, died. In this case, very little difference could be detected between the injured and the non-injured patella.

It being a demonstrated fact that osseous union can be obtained, it behooves us to employ that method of treatment which most frequently secures it.

It cannot be contested that the solidity of the patella contributes, in a great measure, to the stability of the knee-joint. Fibrous union of the fractured bone imparts to the articulation a weakness, an uncertainty, an instability, as a result of which patients with fibrously united patella, frequently fall. This lack of stability, this impairment of control, predispose to refracture of the fibrously united patella. It is exceptional for fibrous union to be associated with absolute functional recovery. In 223 cases of fractured patellæ, non-operatively treated, there were 20 absolute recoveries; in 17 of these 20 cures, at the time of the injury, no separation of the fragments was present. Osseous union resulted in these 17 cases. In only 3 cases of fibrous union did absolute functional recovery result (24). Patients with fibrous union are handicapped noticeably in going up or down stairs. A fibrous bond of union has a tendency to elongate under use.

3. The open operations enable us to obtain a more rapid, a more complete recovery. Koerte considers that the climbing of stairs after fracture of the patella is a criterion of functional recovery. In 25 cases of fractured patellæ treated by the open method, Koerte (24) later examined 23. These 23 had all become able to climb stairs within four and one-half months subsequent to the operation. "The more active the patient is, the more his occupation involves work on different levels, the more is operative treatment indicated," 24*a*.

4. The open operation enables the operator to mitigate all and to remove most of the conditions that tend to cause imperfect union and its consequence, impaired functional integrity. Let us enumerate and discuss briefly the most important of these unfavorable conditions to osseous union.

1. Separation of the fragments.

2. Tilting of the fragments. Either or both fragments, often, are or may be, everted or inverted. In the presence of tilting, the fragments can never be maintained with the fractured surfaces exactly towards each other either by bandages or by retentive appliances, or by any subcutaneous operative method.

3. Rupture of the tendinous expansions of the vasti and of the lateral portions of the capsule of the joint.

4. Prolapse of the præpatellar tissues into the breach caused by the separation of the fractured fragments.

5. Atrophy of the quadriceps femoris due to disuse, arthritis, marked contusions of the muscle, extravasated blood from the joint through the rent in the upper part of the capsule, etc.

6. Arthritis of the knee-joint.

7. Adhesions of the patella. In cases 10½*g* and 75, the upper fragment was found adherent to the femoral condyles.

8. Union of the fragments in bad position, mechanically interfering with proper function of joint.

SEPARATION OF THE FRAGMENTS

This interfragmentary interval, in recent fractures, can be increased by flexion of the leg on the thigh, and lessened by extension of the thigh and leg on the pelvis. In 128 of our cases, the reporters recorded the presence of this interfragmentary separation. The displacement varies with the type of fracture, being practically non-existent in incomplete subaponeurotic fractures, being most marked in such cases as are associated with extensive laceration of the præpatellar and parapatellar fibrous and aponeurotic tissues. A group of powerful muscles is attached to and displaces upward the upper fragment in oblique and transverse fractures. This muscular group must be properly controlled, as it constantly tends to separate the fragments. The retraction of the ligamentum patellæ displaces the lower fragment downwards and also has a tendency to evert its fractured surface. The upward displacement of the upper fragment by the quadriceps extensor femoris muscle, of itself, would not make the open operation imperative, as the contraction of this muscle and the associated displacement of the upper fragment can be greatly overcome by position, by clamps, by forcible and prolonged extension,

by the subcutaneous and percutaneous methods of vertical or circumferential ligaturing of the patella. The open method enables one to determine the extent to which the fragments are separated and to take such steps as may be needed to overcome it. The surgeon is enabled to bring the fragments into more exact apposition and to more positively maintain them there. By the open method, increase in length of the patella is avoided. Increase in the dimensions of the patella is not infrequently noticed after the subcutaneous operations, and sometimes appears to limit mechanically flexion of the knee.

TILTING OF THE FRAGMENTS

One or both fragments may be everted or inverted, or one may be everted and the other inverted. If the bone be fractured into more than two fragments, one or more of the fragments may be everted or inverted. In case 70, the lower fragment was so tilted that the articular cartilage was the part presenting. In case 43*a*, the upper fragment was tilted forward. Its fractured surface was covered with the torn capsule. In case 22*g*, the lower fragment was completely inverted. Tilting of the fragments, though partly due to the traction of the fibroaponeurotic tissues attached to the anterior surface of the patella is mainly dependent, at first, on the intra-articular hæmorrhage, and later, on the inflammatory exudate consecutive to the injury. As these fractures are almost always intra-articular, an associated traumatic synovitis is a nearly constant accompaniment. At times, a spicule of bone between the fragments is a contributory factor. The tilting of the fragments decreases, often disappears completely, with the absorption or with the removal of the extravasated blood and of the inflammatory exudate. By keeping the limb in an appropriate position, by controlling the fragments by elastic or other bandages, so applied as to secure apposition of the fractured surfaces, tilting is further lessened. The open operation enables us to quickly and completely remove the extravasated intra- and extra-articular blood, to void the inflammatory exudate, to make the toilet of the synovial cavity. If, as obtained, in case 80, a loose spicule of bone be displaced between the fragments, its removal is easily effected. The open operative method allows us to completely overcome the tilting of the fragments and to coapt them with a nicety unattainable by any other method.

If, shortly after a fracture of the patella, the knee-joint is opened, it will be found that the articulation contains blood. The quantity of the extravasated blood is not the same in all cases. In some cases, it is small; in others considerable, filling the joint to distention. The blood may be liquid, clotted, or semi-organized. Not infrequently, it originates intra-articular adhesions or loose foreign joint bodies. It is easy to conceive how a large intra-articular liquid collection, can, in transverse or oblique fractures, rotate the upper or lower fragment, or both, about a transverse axis. Baerlocher (cases 92) says: "In every case there was hæmorrhage into the joint."

RUPTURE OF THE TENDINOUS EXPANSIONS OF THE VASTI AND OF THE LATERAL PORTIONS OF THE CAPSULE OF THE JOINT

In fractures of the patella, as in other fractures, in addition to the lesion of the bone, we have coexisting injuries of the contiguous soft tissues. For instance, it is reported that in case 9, the reserve extensor apparatus was completely ruptured. In case 27*b*, the articular capsule and the ailerons were torn as far back as the femoral condyles; in case 27*e*, the capsule on each side of the patella was much lacerated. In case 28, the tear of the lateral patellar structures extended as far back as the junction of the lateral and posterior surfaces of the knee. In case 33, the quadriceps extensor above and below the patella and the præpatellar tissues were extensively contused and divided. In base 43*e*, the præpatellar bursa was involved. In case 96*b*, there was a large oblique rent in the soft tissues from a point about 2 inches below the fracture line on the inner side to the edge of the fracture on the outer side. In case 108*e*, the ligamentum patellæ was ruptured over the apex of the lower fragment. In case 112, the capsule of the joint had been transversely ruptured on both sides, etc., etc.

When one recalls the intimate relations with the patella of the fascia, muscles and ligaments

which surround it, no stretch of the imagination can possibly conceive a fracture of this bone without some associated damage to the surrounding structures. The more extensive that damage, the greater the separation of the bone fragments, the less the liability to spontaneous functional recovery. From the diagnostic standpoint, it is important to determine, if after falling, the patient got up, or if he made any attempts at walking. Attempts on the part of the patient to arise, determine further lacerations of the parapatellar ligaments and consequently further separation of the fragments. Vallas holds that a bad result following a transverse fracture of the patella is due not so much to non-union and wide separation of the two fragments as to unrepaired lacerations of the anterior and lateral portions of the capsule of the knee-joint. Vallas advocates strongly the suturing of all rents in the fibrous investment of the knee. Mickulicz, Baerlocher, Lejars, and Stimson emphasize also the importance of restoring the continuity of the torn reserve extensor apparatus.

Upon the proper repair, upon the proper reunion of these soft tissues is dependent, in an important measure, the functional integrity of the knee-joint. E. W. Andrews says that the patella union is only an incident in the ligamentous and tendinous repair by suture. So important is the approximation of these torn tissues, so essential is the restoration of the continuity of the aponeurotic fibres of the vasti, of the rectus femoris, and of the deep fascia of leg and thigh, that many operators in the treatment of fractured patellæ limit all their suturing to the torn soft tissues. "It has recently been shown that, in operating upon these fractures, it is even more important to suture the lateral ligaments than to suture the patella itself" (31). The tears in the joint capsule and in the aponeurotic fibres allow the quadriceps extensor femoris muscle to still further separate the fragments and to increase the forward eversion of the superior fragment. The open method enables the medical attendant to carefully repair the tears, anterior and lateral, in the joint capsule (the patella forms a part of the articular capsule) and to approximate the margins of all lacerations in the tendinous expansions of the vasti. The active extension of the leg depends in a large measure upon the state of the reserve extensor apparatus.

PROLAPSE OF THE PRÆPATELLAR TISSUES INTO THE BREACH

This prolapse of the præpatellar fibrous tissues between the fragments of the fractured bone is one of the important obstacles to non-union. The prevention by these intervening soft tissues of the exact apposition of the fragments is one of the most valid reasons for resorting to the open operation. When present, these interposed soft tissues constitute an obstacle to osseous union, removable only by the open operation.

Wm. Macerven (32) was the first to demonstrate and to emphasize the importance, from the therapeutic and prognostic standpoint, of these interposed soft tissues. As early as 1887, he reported the following 8 cases, the pathological findings in which show the frequency and the significance of this conditon. These findings deserve careful reading.

Case 1. The structures found intervening between the fragments were, first, the floor of the bursa patellæ; second, the præpatellar aponeurosis; and third, the fibrous expansions attached to either side of the patella.

Case 2. The præpatellar aponeurotic structures lay over the proximal fragment, to which they were firmly attached.

Case 3. The fractured surfaces of both the upper and the lower fragments were covered with the aponeurotic tissues, and with shreds of the bursal floor. No part of their fractured surfaces was bare.

Case 4. Covering the whole upper aspect of the fractured surface of the upper fragment, there was a dense layer of fibrous and aponeurotic tissue. The anterior two-thirds of the fractured surface of the lower fragment was overlapped completely by fibrous and aponeurotic structures which hung over and covered the sides.

Case 5. The aponeurotic and periosteal covering were firmly stretched over the proximal fragment and fixed to its osseous projections. Lacerated folds of the bursa dipped loosely between the fragments.

Case 6. The bursal floor was ruptured; transverse portions of it hung over the frag-

ments, and in the interval between them when they were approximated. The aponeurotic tissue was tightly stretched over the proximal portion of the patella and was firmly attached to its fractured surface by the osseous irregularities of the latter.

Case 7. Aponeurotic structures, and commingled with them shreds of the floor of the ruptured bursa, together covered the fractured surface of the upper fragment for about one-half of its anteroposterior diameter.

Case 8. On carefully separating the bursal floor from the underlying flap of soft tissues, it was seen that the next layer consisted of long shreds of ligamentous structures which were firmly adherent to the spiculæ of the cancellated tissue.

Hoffa (33) induced on 12 cadavers, fractures of the patella, in the following way: after tenotomizing the capsule of the knee-joint, the patella was sawn half way through from below. A chisel was then introduced into the furrow thus made and by its aid, a transverse fracture of the patella was produced. Then, by strong flexion of the knee, the aponeurosis was lacerated. In these preparations, Hoffa demonstrated the irregular, shredded laceration of the præpatellar fibroperiosteal tissues, the interposition between the fragments of these tissues, and the hooking of the torn soft tissues to the osseous projections of the fractured surfaces.

Robert T. Morris says that in all cases in which he has operated, he has found the inversion between the fragments of a large hood of periosteum, and that, in addition, in many instances, firmly organized blood clots were present between the fragments. In case 119, the following statement is made: "In many instances, I have had to use the periosteal elevator, or other similar instrument, for the purpose of separating the fibrous tissue from the fractured surfaces;" in case 43*e*, "the torn edges of the capsule were interposed between the edges of the fragments, the præpatellar bursa was involved"; in case 5, the reporter states: "The fringe of tissue which had fallen between the fragments was removed." In case 24, both fractured surfaces were covered with a tough layer of aponeurosis, etc. In case 74*b*, the fibroperiosteal tissues were so firmly adherent to the fractured surface of the upper fragment that they had to be scraped off.

Warbasse (cases 57) says that without operation exact approximation of the bony fragments would have been, in all his recent transverse fractures, absolutely impossible, owing to the intervention of soft tissues between the fragments.

This fibroperiosteal curtain may overlap the fractured surface of either fragment. In some cases, both fractured surfaces are either partly or completely covered by this prolapsing præpatellar tissue. These prolapsed tissues may be easily removable, may be hooked to the underlying bone. When hooked to the fractured surfaces their removal is, at times, attended with some difficulty. In many fractures of the patella, be they tear or blow fractures, or due to both factors, the præpatellar bursa is contused. Blood and portions of the præpatellar bursa can enter into the formation of the prolapsed præpatellar curtain, being superimposed upon the aponeurotic tissues.

By the aid of the open operation, all interfragmentary soft tissues are easily removable. Bony union presupposes an exact apposition of two osseous surfaces. Blood interposed between the fragments, we do not consider as a foreign body, it being well known that the presence of blood is constant between fractured surfaces. Intervening tissues of other description act as foreign bodies and are productive either of fibrous union or of non-union. We concede that massage relieves pain, promotes the circulation, and aids in the removal of exudates, but can it accomplish anything towards the removal of the soft tissues that have prolapsed in the breach between the fragments? The attempt to remove the interfragmentary soft tissues by rubbing the fractured surfaces one upon the other is illusory. Interposed soft tissues can be removed with certainty only by means of the open operation.

ATROPHY OF THE QUADRICEPS FEMORIS MUSCLE

This atrophy is due, partly to disuse, partly to extravasation of blood in the substance of the muscle, partly to associated injury to the muscle and to its contained nerve filaments. By the aid of the open operation, all blood extravasates can be removed, fascial tears sutured.

The patients regain the use of their limbs in a comparatively short period of time, the period of immobilization is markedly shortened. Active use prevents and overcomes atrophy attendant upon disuse. It is said that "an ounce of voluntary exercise is worth a ton of massage in the treatment of muscle atrophy" (34). Atrophy of the quadriceps extensor femoris was recorded in cases 1, 10, 65, 116, etc. The early removal of all extravasated blood, liquid or clotted, from the articular cavity and from the periarticular tissues, limits the liability to the formation of adhesions, intra- and extra-articular in nature.

By the employment of the open operative treatment, all the above-mentioned obstacles to restoration of functional integrity can be more rapidly, more effectually overcome than by resorting to non-operative methods of treatment, separate or combined. The open method makes possible the removal from the joint cavity of detached bony fragments; it enables the operator to absolutely prevent the union of the fragments in a faulty position, that is, in a position mechanically interfering with the proper function of the joint; the tendency to adhesion of the upper patellar fragment to the femoral condyles is lessened. Increase in the dimensions of the patella following the open operative treatment is a rarity. Any increase in the dimensions of the patella is very liable to interfere with the adaptability of the patellar and femoral articular surfaces.

In fractures of the patella, as in other fractures, the closer the apposition of the fragments, the greater the probability of osseous union, of osseous repair, and consequently, the more probable the restoration of functional and anatomical integrity. We know that the patella is a bone of feeble regenerative power, having only one periosteal surface, nevertheless, if the conditions requisite in other bones to obtain osseous union are secured in fractures of this bone, the same satisfactory results will be obtained.

Under what conditions is the open operative treatment of doubtful propriety or not indicated?

In formulating indications and contraindications for the open operative treatment of fractures of the patella, we give only slight consideration to age, sex, and occupation. Individuals of either sex, at all periods of life, and in all walks of society, need a good patella. However, in this, as in all other operations, the state of the tissues and of the viscera must not be ignored. Such anatomical and physiological deterioration of the tissues may be present as to compel us to regretfully substitute inferior therapeutic measures to operations of election. The facts can be stated to the patient and he can select between functional integrity and functional disability. Thiem (24) gives only two conditions as contraindicating operations:

1. Absence of separation of the fragments. (No diastasis.)
2. No loss of extension.

WE DO NOT ADVISE THE OPEN OPERATION

1. *a.* In fractures of the patella that occur in a diabetic patient. The tissues of diabetics offer very little resistance to infection. They are tissues of impaired regenerative power. Nevertheless, an absolutely bad prognosis need not be given in these cases. Chaput (35) reports a case of refracture of a patella occurring in a diabetic. At the time of the first fracture, the bone had been wired. The refracture, owing to the coexistence of diabetes mellitus which affection had developed since the first operation, was treated non-operatively. The patient recovered with a knee admitting of complete extension, and of flexion to a right angle despite the persistence of a 3 cm. interval between the fragments. In case 78 of our tables, the reporter states that the patient developed glycosuria during convalescence. No union whatever took place. Nevertheless, the patient recovered with a knee admitting of flexion to a right angle and which enabled him to walk quite well. The fragments were held together, solely, by the silver wire sutures.

b. In fractures of the patella occurring in patients having advanced tubercular disease.

c. In fractures of the patella occurring in patients suffering from well developed cardiac, renal, or hepatic disease.

2. In closed longitudinal fractures, with no displacement, or with but slight lateral displacement.

In fractures of this type, recovery almost invariably follows the combined use of such measures as massage, immobilization, full extension of leg on thigh, coaptation of the fragments by retentive apparatus. "Osseous union is constantly obtained in longitudinal fractures of the patella." Macewen (32). This statement of Macewen admits of very few exceptions. Meyer (36) used non-operative treatment in all his cases of longitudinal fracture (the diagnosis in each case had been verified by X-rays). He obtained excellent functional recoveries in all of them.

Other cases of longitudinally fractured patellæ successfully treated by non-operative measures are reported by Hintz, Kofmann, and others. In Hintz's case (37), the patella was split longitudinally into an anterior and a posterior half. There was some vertical displacement. Massage, recovery. In Kofmann's case, at time of discharge of patient, locomotion, though possible, was painful. It is to be kept in mind that in longitudinal fractures of the patella, as well as in other types, too early use of the limb is liable to result in refracture.

A case of subcutaneous longitudinal fracture of the patella occurring in an acrobat is reported by Hoffa (33*a*). The case having been treated unsuccessfully by non-operative measures, Hoffa opened the articulation and then sewed the fragments together with strong silk. An excellent recovery followed.

In the literature of the last ten years, I found in addition to the above cases, only 2 other cases of longitudinal patellar fractures treated by the open method. Cases 92, 123*a*, the last was compound in nature.

3. Do not operate in subaponeurotic or in incomplete fractures. Reichel calls these fractures "subligamentous." König alludes to these cases when he states that in a certain number of fractures of the patella, the bone can be fractured and the overlying aponeurosis remain intact. Owing to the absence of detectable separation, of detectable displacement of the fragments, as well as of other typical symptoms, these fractures often escape recognition, often are diagnosed contusions, etc. The X-rays reveal the line of fracture easily and distinctly. It is important that these cases be accurately diagnosed. By non-diagnosis and consequent injudicious treatment, these cases that call for non-operative treatment can easily be converted into cases calling for an arthrotomy. Wegner (15) reports 3 cases of knee-injuries associated with disability of some duration. Previous to the taking of skiagrams, the exact nature of the condition had not been recognized. The X-rays showed that the patients were suffering from subaponeurotic transverse fractures of the patella in which the interfragmentary diastasis could not, or had not, been detected clinically. These X-ray pictures also proved that tear fractures can occur without very evident diastasis of the fragments. In Oehlker's cases (108) are included 2 cases of infracted patella, in which the exact diagnosis would not have been made if the reporter had not resorted to skiagraphy.

4. Fractures of the patella in which the separation of the patellar fragments is so slight as to be barely detectable do not call for the open operative treatment. The same applies to fractures in which the injuries to the accessory patellar ligaments are unimportant. Vallas (35*a*) demonstrated to the Société Médicale de Lyons a patella which had been the seat of fracture several years before the patient's death. Vallas had treated the fracture non-operatively. At the time of fracture, the patient had immediately lost consciousness and, therefore, had made no attempt to arise. After these fractures, attempts to get up cause further laceration of the soft tissues, provoke further intra- and extra-articular hæmorrhage. As a consequence of the lacerations and the hæmorrhage, there results a greater separation and a greater eversion of the fragments. Upon the patella shown by Vallas, it was impossible to detect the site of a previous solution of continuity. There had been complete osseous union.

After all injuries to the patella, we invariably have a skiagram of the traumatized patella taken. Failure to skiagram cases of this nature may lead to the overlooking of a fracture. Barker (14½) reports a case of fractured patella, in which the knee showed little sign of injury, and in which the fracture might have been easily overlooked had it not been that the ski-

agram revealed an extensive stellate fracture of the patella.

5. Do not operate on patients who prefer to pass their lives partly disabled rather than to run the minimal dangers of an operation.

The popularity of the open methods is increasing. In careful and skillful hands, the dangers formerly incident to their employment can now be said to be non-existent. Kocher himself has become an earnest advocate of the open operative treatment. In Von Bergman's clinic, it is regarded, since 1893, as the routine treatment for transverse fractures of the patella.

With increasing familiarity with the successive steps of the operation and a better appreciation of a judiciously carried out after treatment, the results attending its employment are becoming more and more satisfactory. The perusal of our tables furnish ample confirmation of this statement.

For this very important addition to our surgical resources, we are chiefly indebted to Lord Lister (39). Lucas-Championnière (40) one of the pioneers and also one of the most enthusiastic advocates of the open operative treatment for fractures of the patella, states that the first antiseptic operation of patellar suturing was performed by Cameron of Glasgow in 1877. Lister reported his first case in 1877. In 1883, he reported six more cases and then showed clearly that this new method of treatment was followed by perfect recovery, while previous to that time the condition had been looked upon as being, of necessity, followed by lameness. The adoption of this form of treatment among German-speaking surgeons is largely due to the efforts of Hackenbrush, Trendelenburg, and König. Trendelenburg performed the first open operation in Germany in 1878. Among the French speaking surgeons, the following are some of the ardent and most prominent supporters of the open operative treatment: Chaput, Berger, Lejars (Paris), Mayer, Lambotte (Brussels), Vallas (Lyons). It was Berger (Paris) who introduced cerclage.

Our tables show the following results:

Miscellaneous methods, 33 cases:
Good results, 32 cases; deaths, 1,— from apoplexy.
Circumferential looping, 28 cases:
Good results, 28 cases.
Apposition of the bony fragments and suturing of the soft tissues, 240 cases:
Good results, 230 cases; fair results, 3 cases. In one case (case 35) though the fragments are 8½ cm. apart, patient walks with but little difficulty.
Bone suturing, 809 cases:
Good results, 730; not definitely stated, 50; moderately good, 20; bad results, 10; ankylosis, 10; deaths, 5. One of the patients had syphilis. In case 78 there was glycosuria; wires held fragments, but there was no union.
Case 86*b*. 1 infection. Patient at time of accident was in bad general condition.
Cases 92. 1 delirium tremens; 1 pneumonia.
Case 110. 1 pulmonary embolism.
Case 132. 1 infection incident to the operation.

It is our belief that, after ample preparation of the patient and of the operative field, the open operative treatment is positively indicated:

1. In all fresh fractures of the patella in the absence of contraindications:
   - *a*. If the surroundings are favorable —
     1. An aseptic operating room.
     2. Skilled surgeon, and assistants having "an aseptic conscience."
     3. Dependable suture material, rubber gloves, etc.
   - *b*. If the patient is in the best possible condition.
   - *c*. If the fracture be of such a nature that a disabling defect is to be expected, if one resorts to non-operative treatment.
   - *d*. When the bony fragments cannot be returned exactly by manipulation to their normal position and retained therein by retentive apparatus.

2. In all compound fractures. The following cases are some of the compound fractures that appear in our tables:

RESULTS

Case 6½. One month after operation patient could walk.
Case 10½*p*. Movements allowed on 12th day after operation.
Case 17. Cure.
Case 23. Full recovery. Motion all that could be desired.
Case 25. After four months, normal flexion and extension.
Case 33. Patient walks without a limp and can cycle as well as formerly.
Case 50. Gait normal; firm union of the patella.
Case 53. Patient could walk again on 40th day.
Case 57. Good result.

Case 59. No disability; as strong as ever.
63*a*. Good result.
63*c*. Complete restoration of joint-function in three months.
Case 74*a*. At end of nine months, function was normal in every particular.
Case 92. Two cases. One case: osseous union; one case: complete restoration of function.
Case 95*a*. Usefulness of limb perfect.
Case 99. Result excellent.
Case 101. Two months later left hospital with an almost perfect limb.
Case 111. Two cases. One month after operation joint admitted of slight flexion and extension. Other case also resulted in recovery.
Case 123. In one case, 10 degrees of flexion. In another case, complete extension, 50 degrees flexion. Able to get about without any difficulty.

3. In all comminuted fractures. Almost all the compound fractures above enumerated were also comminuted fractures. Among the closed comminuted fractures included in our table are the following:

Case	No. of Fragments	Result of Operation
10½*h*	7	Bends knee to nearly a right angle.
13	5 or 6	Good result.
14½	7	Good.
17	7	Cure.
34	6	Motion nearly normal.
54	Not several loose fragments had to be removed.	Functional result admirable.
63*c*	Not stated.	Bony union. Complete restoration of joint function in 3 months.
80*b*	Not stated.	Bony union. Able to bend knee to an angle of 110 degrees.
95*a*	Not stated.	Usefulness of limb perfect.
101	7	2 months later, left hospital with almost perfect knee.
112	6	6 months after operation could walk 6 or 7 miles without discomfort.
117*a*	Operator removed nine pieces of loose bone.	Good.
118	Five fragments and several splinters.	Osseous union.
125*a*	Several fragments.	A month after discharge power of flexion almost normal.

4. In all cases associated with considerable intra-articular effusion. The separation and tilting of the fragments is partly produced and partly maintained by the intra-articular effusion, be the latter hæmorrhagic or inflammatory in nature. The reader is referred to the following cases:

RESULTS

Case 5. Perfectly satisfactory.
Case 7. Recovery uneventful.
Case 18. Five months after, the knee was skiagraphed. It was impossible to detect either the slightest solution of continuity or the slightest deviation of the fragments.
Case 24. Three weeks after, patient was walking without a limp.
Case 55*a*. Patient could walk without a limp.
Case 67. Flexion can be made to a right angle, extension being almost complete.
Case 70. A skiagram taken 3 weeks after injury showed such accurate approximation that the fracture line was barely discernible.
Case 93. Patient walked in 15 days.
Case 105. Good result.
Case 120. Good result.
Case 126. Good result.
Many similar cases could be cited.

5. In all cases associated with marked laceration of the periarticular tissues (ailerons, reserve extensor apparatus).

RESULTS

Case 21. On the 18th day walked unaided.
Case 27*d*. Forty days after operation could walk without crutches; could flex limb to a right angle.

6. In all cases in which the interfragmentary space or diastasis has not at any time exceeded 3 cm. This extent of separation cannot occur without laceration of the accessory patellar ligaments without rupture of the overlying fibroperiosteal tissues. Chaput (35) as a result of experiments on dissecting room subjects came to the conclusion that the interposition between the fragments of the præpatellar fibroperiosteal tissue does not occur if the diastasis fails to reach 3 cm.

Case	Diastasis	Result
11	4 inches	Excellent result. In a month was able to walk fairly well.
29	3 cm.	Good result. It is not possible to recognize that there has been a fracture.
32	3 cm.	Good result.
43*b*	2 inches	Bony union. Perfect function.
47	6 cm.	Can walk in a perfect manner.
66	6 cm.	On 70th day coaptation perfect. Apparently good bony union.
67*a*	2 inches	Healed by first intention; with close coaption and perfect bony union.
90*a*	2½ inches	Almost normal movement.
90*c*	2½ inches	Patient persistently refused to follow instructions, hence results are imperfect.

7. In such fractures as are very liable to cause serious functional joint impairment; among such may be cited, cases in which bony fragments have escaped into the articular cavity, as in case 13, in which three loose pieces of bone were removed from the joint; operation, good result. Patient walked out on 28th day. As in case *22g*, in which lower fragment was completely inverted, or in such anomalous cases as case 104, or such cases as case 70, in which the lower fragment was so tilted that the articular cartilage was the part presenting. In this last case, a skiagram was taken three weeks after the operation. It shows such accurate approximation of the fragments that the fracture line was barely discernible.

8. In all fractures of the patella occurring in individuals upon whom at one time or other a leg or thigh amputation has been performed. To such individuals complete integrity of function in the remaining limb is of the highest importance.

9. In all fractures of the patella occurring in individuals having some permanent functional impairment of the opposite knee, for instance, in case *22n*. In early life, this patient's left knee had been resected. At the age of 35, she fractured her right patella. It was circumferentially looped by the open method. The coaptation was perfect. Result "very satisfactory."

10. In all individuals who, having sustained a partial amputation of the leg, can, for flexion and extension of an artificial limb, derive benefit from the preservation of the integrity of the extensor apparatus of the leg. In case 88, the lower third of the leg had been removed. Two months later, while walking on crutches, patient fell and fractured the patella of the same limb. It was wired. Complete restoration of the knee-joint movements resulted.

11. In all bilateral fractures of the patella, be they of simultaneous or of successive occurrence. In bilateral patellar fractures, it is reasonable to assume some risk in an attempt to transform an almost certainly dependent individual into a self-supporting one. The following bilateral fractures appear in our tables:

SIMULTANEOUS BILATERAL FRACTURES

Case	Simultaneous Fractures Cause	Result
10½*e*	Direct violence.	Bony union. Follows usual employment.
22m	Direct violence.	Very satisfactory result.
44	Both patellæ snapped as patient was endeavoring not to fall.	Most satisfactory result.
57 2 cases	Not stated.	Good result.
59	Fell to sidewalk from second story window.	Left patella was removed. Right patella wired. Firm union. No disability. As strong as ever.
62*a*	Not stated.	Very successful.
73*a*	Received the impact of two hand trucks.	Recovery in four weeks Perfect union.
73*b*	Getting off from street car, fell on both knees. The right patella had been fractured six years before.	Full use of joint.
97	Both knees struck the ground as a result of a fall while descending steps.	Osseous union and restoration of function.
125*b*	Not stated.	Patient can walk without crutch or cane.

SUCCESSIVE BILATERAL FRACTURES

Case	Interval Between Fractures	Cause	Result
6	Not stated.	Not stated.	Perfect result.
10½*m*	1 yr.	Missed kick at dog.	The patella treated operatively. Was as good after a month as the non-operatively treated after 18 months.
52	Not stated.	Not stated.	Not stated.
62*b*	1 yr.	Not stated.	Very successful.
90	9 yrs.	Muscular action.	Almost normal movement.
96½	6 months.	One fracture in alighting from car. The other fracture by horse lurching against him.	Good result.
115	2 yrs.	Not stated.	Function normal in both knees.
124	5 or 6 years	Tripped over slight obstacle.	Good result.

12. In all refractures in the absence of contraindications. The following refractures appear in our tables:

REFRACTURES FOLLOWING NON-OPERATIVE TREATMENT

Case	Time Interval	Cause	Result
1	9 mos.	Not stated.	Patient works in field. Can flex his knee.
12*b*	Short interval.	Not stated.	Two months after, patient can do heavy farm work.
27*d*	26 yrs.	1st fracture, fell from wagon. 2d, not stated.	40 days after operation patient could walk without crutches. Could flex limb to a right angle.
35	3 mos.	First fracture due to horse-kick. Refracture in going upstairs.	Fragments are separated by an interval of 8½ cm. Patient walks, rides bicycle, etc.
47	A long interval.	Refractured by running into an obstacle and falling backward.	Cure. Can walk almost in perfect manner.
63*b*	A few mos.	Refractured while lifting a heavy load.	In four months, knee normal.
65*b*	4 mos.	Slipped and fell against stone.	Fifty days later, flexion of 70 degrees.
71	6 mos.	Refractured patella while jumping a moving freight train.	Good result.
75	A few mos. In this case the patella was twice refractured, once after operative and once after non-operative treatments.	A fall.	Motion normal Firm bony union between the fragments.
76	One year.	In a state of intoxication, fell. Fracture was at a higher level.	Perfect recovery.
83	One year.	Fall.	In six weeks patient was walking. Almost perfect function.
90*b*	8 months.	Muscular action.	Bad functional results.
95*d*	One year.	Slipped on ice and ruptured fibrous band.	Useful limb resulted.
102	3 months. 7 mos. after above. *b* 10 mos. *c* 8 mos. *d* 9 mos.	Made an attempt to restrain a fall. Slipped from ladder. Fell upon knee. Made a misstep. Overflexed knee.	Recovery. Full functional recovery. Patient has pain in going up stairs. Uses cane. Unsatisfactory. Good.
109	22 months.	Not stated	Motion is more or less limited, but the patient has a perfect patella.
125*b*	Some years before.	Not stated.	Lower patellar fragment had to be excised, useful joint resulted.

REFRACTURES OCCURRING IN CASES IN WHICH THE PREVIOUS FRACTURE HAD BEEN TREATED BY THE OPEN OPERATIVE METHOD

Case	Time Interval	Cause	Result
6	Not stated.	Not stated.	Perfect result.
52	A few mos.	Not stated.	Not stated.
55*c*	2 mos.	1st time, fell striking knee. 2d time, jumped from a wagon and fell to the ground.	Limb as useful at it was before the first fracture.
57 2cases	Not stated In one the fracture was at the old line of union. In the other, it was at a new site.	Not stated.	Good result in both cases.
60 4cases	One, 3 mos. One, 4 mos. One, 6 mos. One, 3 yrs.	Not stated.	Osseous union in all four, apparently.
67	5 months.	Slipped and fell.	Extension strong and complete. Flexion to a right angle.
68*a*	3 months.	In effort to restrain fall, fell on back and refractured patella.	Very good functional recovery.
68*b*	2 months.	In an attempt to increase motion under narcosis, separation of fragments resulted.	Good result. Flexion to right angle. In this case the first fracture was treated by the open operative treatment, the refracture, simply by immobilization for 6 weeks.
73*b*	Six years.	Fell off street car and struck on pavement with both knees.	Full use of joint.
81	3½ months.	First fracture due to impact of falling body. Refracture due to slipping.	Osseous union. Excellent function.
84	Not stated.	Not stated.	Not definitely stated.
90*b*	2½ yrs.	Muscular action.	Discharged 73 days after with some, though not solid, union.
93	About 3 mos.	Fall.	Recovery.
110 2cases	One, 10 yrs. One, 6 wks.	Not stated. While horseback jumping.	Good result. do. do.
120	6 mos.	While lifting heavy weight.	Complete bony union. Good result.
130	6 weeks.	Fell.	Patient has now perfect joint.

13. In old fractures of the patella, associated with marked impairment of function, if the functional loss be dependent wholly or partly upon one or more of the following factors:

1. Long fibrous union.

2. Union in a faulty position, in a position that mechanically interferes with the proper function of the joint.

3. Absolute non-union.

4. Ankylosis of the upper patellar fragment to the femur. In case 10½g, there were firm adhesions between the patella and the femur. In case 75, the upper patellar fragment was adherent to the condyles. The quadriceps had contracted to such a degree that without operation the fragments could not have been brought into apposition.

5. Extensive non-repaired lacerations of the aponeurotic capsular and other fibrous tissues. These lacerations hinder restoration of function, increase the fragmentary diastasis.

The patella is only a part of the extensor apparatus of the leg; an important part, we admit, but not the sole part.

6. In all cases in which non-operative treatment has been followed by unsatisfactory results. In operating on old fractures of the patella it is imperative, previous to the apposition of the fragments, that the fractured surfaces either be freshened or that a thin slice of bone be sawn off from each of the surfaces.

In looking over our tables it can be easily ascertained that there is always present in old fractures, a marked separation of the fragments. Further, as a general rule admitting of many exceptions, it will also be noticed, that the older the fracture, the greater will be the degree of secondary contraction and of atrophy undergone by the quadriceps extensor muscle. The more marked this muscular atrophy and the greater the interfragmentary diastasis, the more disabling will be the functional impairment.

Case	Interval Between Injury and Operation	Diastasis	Result
1	18 months.	7 cm.	Patient works in the field, can flex knee.
9	5 years.	12 cm.	Six weeks later, complete normal function.
10	14 years.	6 cm.	At end of year, could go up and down stairs.
11	6 months.	4 inches.	In a month, was able to walk perfectly.
14	4 months.	3 fingers' breadth.	Eight months after, extension was complete. Flexion limited to right angle.
22*a*	5 months.	1½ cm.	Patient perfectly cured.
22*e*	6 months.	Bilateral–R. P. 5 cm. L. D. 7 cm.	Very satisfactory result.
26	1 year.	3 fingers' breadth.	Satisfactory result.
35	6 months.	10 cm.	Functional improvement. After operation the fragments were 8½ cm. apart. By manipulation this could be lessened to 4 cm.
37	4 months.	6 cm.	Excellent result functionally.
54 10 cases	Not stated.	Not stated.	In eight cases, functional results were admirable.
57 6 cases	Not stated.	Not stated.	All recovered with osseous union. Operated on account of fibrous union.
62	Not stated.	Not stated.	Cured.
65*a*	2 months.	A finger's breadth.	Recovery.
65*b*	6 months.	A finger's breadth.	In 50 days, flexion of 70°; extension complete.
65*f*	2 months.	2 fingers' breadth.	In 30 days, O.K. flexion of 100 degrees.
67*a*	5 months.	2 inches.	Healed by first intention with close coaptation and perfect bony union.
72	2 mos. 3 days.	Not stated.	Regained full use of limb.
75	Several mos.	3 inches.	Firm bony union between fragments.
79	18 months.	2 cm.	Almost complete extension. Flexion to 150°.
86*b*	12 wks.	2 cm.	Osseous callus. Function normal.
86*c*	8 wks.	2 cm.	Firm union. Flexion 45°. Extension normal.
86*d*	5 months.	4 cm.	Osseous union. Full normal function.
86*e*	3½ months.	2 cm.	Osseous union. Extension free. Flexion 90°.
102 7 cases	Not stated.		In four, the results were good. In the other four, they were only fair.
109	2 months.	Not stated.	Motion more or less limited, but patient has perfect patella.
115	2 yrs.	6 in. in flexion; the diastasis reaches 10 cm.	Function normal in both knees.
124	6 months.	2 inches.	Good result.

In old, as well as in all other fractures of the patella, we must, in addition to repairing the tears in the soft tissues, endeavor to obtain osseous union of the fractured bone. This desideratum can be effected only by securing an exact, an accurate apposition of the freshened fractured surfaces. Consequent to the fracture and to the disability which it entails, there develops a retraction and an atrophy of the quadriceps extensor femoris. (Cases 1, 9, 10, 65*f*, 98, 115, etc.) This muscular contraction, this muscular atrophy, is the most important cause of the great difficulty, a diffi-

culty at times almost insurmountable, which we encounter in our endeavors to approximate, to appose, to reunite the bony fragments. As easy as is the primary suture of a fractured patella, just as difficult can be the suture of an old fracture of the patella. It is convenient, from the operative standpoint, to classify old fractures of the patella into:

A. Those in which the fragments can be approximated with but little difficulty.

B. Those in which owing to the coexisting atrophy and unusual retraction of the quadriceps extensor femoris muscle, the approximation or rather the exact apposition of the fragments is a difficult feat to accomplish.

In cases in which the fragments can be approximated with but little difficulty, the operation will differ from that performed in recent fractures only by requiring two additional steps. 1st. The resection of the interfragmentary fibrous callus. 2d. The freshening of the fractured surfaces. It is essential that the interfragmentary gap be overcome. Z-shaped incisions for lengthening of the quadriceps may have to be performed (case 115). To approximate the fractured surfaces, preoperative massage, position, and traction at times suffice. If these measures fail to secure the relaxation, the lengthening of the quadriceps necessary to obliterate the interfragmentary gap, a plastic operation is indicated.

In such cases of old fractures as come under type "*B*," certain operators, in order to obtain some functional improvement, have resorted to such measures as the upward transplantation of the tibial tubercle, as osteoplasty on the patella (47), as the removal of one or of all patellar fragments, etc. Helferish placed pieces of sterilized bone in the gap; Wolff bridged over the gap with bone flaps chiselled from the upper and lower fragments. The case at hand determines the nature of the plastic operation to be performed.

In the presence of such a difficulty, Rosenberg (case 1) proceeded as follows: Beginning 1 cm. above the insertion of the quadriceps extensor tendon, he carried his incision transversely midway between the anterior and posterior surfaces of the quadriceps to the base of patella. The patella was then sawn transversely an equal distance between its anterior and posterior surfaces to the beginning of the fibrous callus. The same procedure was performed upon the ligamentum patellæ and the inferior fragment. The osseous flaps were turned toward each other; the tendinous tissue taken from the quadriceps and the ligamentum patellæ were thus in juxtaposition. They were sutured to each other. Six weeks after operation the patient was discharged.

In case 9, Schanz resorted to the following expedient: The Sartorius muscle was laid bare from its insertion to the middle of the thigh. Leaving its (Sartorius) insertion undisturbed, the muscle was lifted from its bed. A longitudinal groove was made in the patellar fragments. In this groove the Sartorius was im bedded, then fixed with wire to the bone and sutured also to the interfragmentary fibrous callus. In case 115, the operator displaced the anterior tibial tubercle upward and also resorted to "Z" shaped lengthening of the quadriceps extensor muscle. In cases 4*a* and *b*, the reporter used with success Ferrarei's method, the technique of which is the following:

A longitudinal incision, 15 cm. in length, is made over the middle of the patella. It starts at a point 7 cm. above the base of the patella, extending downwards to a point below the apex of the bone. The tendon of the quadriceps extensor, the patella, and the ligamentum patella are exposed by this incision. From the tendon of the quadriceps femoris a tendinous flap is dissected. This flap should be about 2 m.m. in thickness. It should be of the same length and of the same width as the patella, so that when reflected downward, the whole anterior surface of the patella will be covered by it. Its base is to remain attached to the base of the patella. While an assistant draws together the bony fragments, the tendinous flap is turned down on the surface of the patella and fixed by means of a looped suture to the upper portion of the ligamentum patellæ. The flap is united with interrupted sutures to the lateral ligaments and to the tendinous structures that surround the patella, in such a manner that this bone remains covered and united by a cap of fibrous tissue. The edges of the gap left in the tendon of the quadriceps femoris are brought together by three or four sutures. Skin is then sutured.

In some of the other cases of ancient fractures (10, 11, 14, 22*a*, 26, 37, 54, 57, 65*j*, 109) the operator deemed it sufficient to first resect the interfragmentary fibrous tissue, as in case 14, then to freshen, as in cases 10, 11, the fractured patellar surfaces; in a few of the cases, as in case 37, slightly lengthening the quadriceps extensor tendon by the aid of lateral incisions, and following these different steps by either suturing the bony fragments or by circumferentially looping them, or by apposing the freshened surfaces and suturing the soft tissues over and around them. Some of the operators have obtained excellent results in the same cases by suturing the fragments and looping the patella; then supplementing these two procedures by a careful repair of the torn præpatellar and parapatellar fibrous tissues. Vallas states that in old fractures, the suture of the "ailerons" (retinaculæ patellæ B. N. A.) can only be effected by resecting the cicatricial tissue of the capsule. The measures employed in each individual case are stated less briefly in the tables at the close of this article.

Which is the most universally applicable of the three main types of operation that are now in vogue for the treatment of fractured patellæ?

The results obtained by the employment of any of these three dissimilar operations, osseous suture, cerclage, suture des ailerons, have been, when the operation was performed by competent hands, so gratifying, that it is embarrassing to suggest that one of them be abandoned. With each of these different methods, excellent functional and anatomical recoveries have been obtained. Osseous suture has given satisfactory results. Cerclage has secured excellent recoveries. As to the third method, it has been truthfully said: "In fractured patellæ absolutely perfect results from the standpoint of contour, solidity, and function have been obtained, in a relatively short period, in cases in which all suturing was limited to the præpatellar and parapatellar fibrous tissues (Peyrot)." Whichever method be employed, the repair of the soft parts is all important. The importance of this step is emphasized by most of the advocates of osseous suturing. Baerlocher, 92, Bockenheimer, 110, Mickulicz, 84, Oehlker, 105, and Trendelenburg, 113, and others, though they suture the bony fragments, never fail to supplement the latter step by suturing of the soft tissues.

In recent fractures of the patella, I have abandoned osseous suturing. I have not yet seen a case of old fracture of this same bone in which I felt that a good result could not be obtained without the employment of osseous suturing.

To my mind osseous suturing, as a method of treatment for fractures of this bone, has the following shortcomings:

a. It calls for special instruments.

b. The perforating instrument may break, and the broken portion remain embedded in the patella. Annequin (42) reports a case of this nature. The drill broke and a fragment of it was left in the patella.

c. It is a procedure not universally applicable:

1. It is unsuited to the treatment of comminuted fractures.

2. It cannot be used to advantage in cases in which there is great inequality in the size of the fragments; one very large and one very small fragment. The lower or upper fragment may be that small that it could only afford an insufficient hold to the sutures. In case of this description, many of the advocates of osseous suture resort to Quénu's "hemicerclage," operation as in case 11*a*. In this operation, hemicerclage, the larger fragment is perforated transversely and the binding ligature is passed through this perforation and either through the ligamentum patellæ or through the quadriceps extensor femoris, through the latter if the lower patellar fragment be perforated; through the former, if the upper patellar fragment be the one perforated. Longitudinal suturing of the fragments may be owing to the unequal volume of the fragments or to their multiplicity, a very difficult operation.

d. In cases of abnormally friable fractured patella, attempts to perforate the fragments may provoke further splintering of the same, as in case 53. The slow elimination of splintered fragments prolongs convalescence, retards recovery. Some observers claim that the patella which fractures, is a friable patella, some claim that hereditary friability of the patella is an etiological factor in the causation

of fractured patellæ. Hebb (41) in the Lancet reports a case of a fractured patella as follows:

"In the Westminister Hospital, there is, at the present time, a patient, age 38 years, with a transverse fracture of the right patella. Nine years ago, the same man fractured his left patella. His father, when twenty years old, sustained a fracture of his right patella; a brother at the age of 35 years, also had a fracture of his right patella; another brother at the age of 32, also fractured his right patella."

All these accidents were the result of indirect violence. These men are all healthy men and carry on different trades.

e. The proper boring in the patella, from before backwards, of channels for the introduction of the sutures, demands experience. At times, it is difficult of execution. The perforation of the bony fragments always complicates and always lengthens the operative procedure.

f. In cases of secondary operation, the fragments may have become so atrophic that they are incapable of holding the sutures. The latter are liable to cut out, the moment any strain is put upon them; as in case 35, in which the fragments were so soft that a medium pull upon the silver wire cut into them.

Most of the advocates of osseous suture are of the opinion that greater stability and more accurate apposition is secured by the employment of at least two osseous sutures. Each additional suture calls for two additional perforations. Additional perforations inflict additional trauma upon the periosteum and upon the bone. In arthrotomy, as in other operations, the more the tissues are manipulated, the greater is the infliction of trauma and the more is the liability to contamination and infection of the tissues enhanced. It is the possibility of consequent infectious complications that has retarded the general adoption of the open operative methods. The manipulation and trauma of the bone and of the soft tissues, which is inseparable from the employment of osseous suturing, adds materially to the dangers of the open operative treatment. The trauma to the bone is far less significant if the perforations be effected with the aid of an electric motor.

g. It is needless. It adds injury to injury. Equally good if not better results are obtained by less difficult and less laborious methods.

Open circumferential looping was introduced by Berger (42*a*), of Paris. It is employed by the advocates of osseous suture of fractured patella, in cases:

1. In which one of the fragments is too small to admit of perforation previous to the introduction of the silver wire, steel wire, or other employed sutured material.

2. In which one of the fragments is too small to be directly sutured to the larger fragment.

3. In fractures with many fragments or with comminution.

4. In cases of abnormal friability of the patella.

It has been and is still extensively employed in the treatment of fractured patellæ, as (*a*) a supplementary measure to osseous suture; (*b*) as a preliminary, or as a supplementary measure to suture of the præpatellar and parapatellar tissues. By many, it is employed as the only operative step in the treatment of fractures of the patella.

The advantages of circumferential looping or cerclage are (*a*) that its employment inflicts no additional traumatism upon the periosteal and osseous tissues. The osseous and cartilaginous surfaces are uninjured by the passing of the circumferential ligature. It respects the skeleton. (*b*) That the ligature material which loops the patella is totally extra-articular. It is introduced and embedded in the peripatellar tissues. Should a metallic ligature, such as silver wire, be used and its presence subsequently cause real or imaginary disturbances, the removal of the real or supposed offending agent can easily be effected without opening the articulation. It respects the articulation. (*c*) The method is of easy and of rapid execution. The maneuvers incident to its introduction are extra-articular. It can be used as a preliminary or as a supplementary step to any of the various open operative methods in vogue. It no doubt contributes to the exact coaptation of the bony fragments. As far as it goes, this procedure (cerclage) is safe, logical, and serviceable. No special instruments are required for its performance. To our eyes, circumferential looping, as a method of treatment, has the shortcoming of

insufficiency. We use cerclage as a preliminary, or as a supplementary measure to suture of the præpatellar and parapatellar tissues.

Study of the literature of the subject, surgical experience, and clinical observation have led me to consider that the following are the most universally applicable operative steps to be conjointly employed in the treatment of such fractures of the patella as demand operative intervention.

1. The torn præpatellar fibroperiosteal sutures must be carefully sutured. E. Wyllis Andrews, instead of uniting these torn præpatellar tissues, end to end, sutures them in such a way that they overlap one another, that is, they are imbricated one within the other, "shingled as it were."

2. All tears in the parapatellar tissues must be sewed up. It is imperative that all capsular rents be carefully repaired. The suturing of the peri- and parapatellar soft tissues has the approval of all clinicians.

3. To contribute to the maintenance in apposition of the fragments, the patella is circumferentially looped by a ligature passed close to its periphery. This ligature is passed so as to be close to the periphery of the bone, so as to hug it, as it were. It is inserted in such a way that it lies imbedded in the substance of both quadriceps tendon and ligamentum patellæ midway between their anterior and posterior surfaces. If deemed necessary, two such looping ligatures may be used. These different maneuvers are all extra-articular. In some comminuted fractures in which the interfragmentary diastasis was slight and in which the præpatellar tissues were practically untorn, I have often limited the operative procedure to looping the patellar fragments and to fortifying the præpatellar tissues by the introduction of a few V-shaped kangaroo tendon sutures, not exposing the articular surfaces to inspection.

a. Should one, if he be an advocate of the open operative treatment, operate on the day, or on the morrow, of the infliction of the injury, or should he wait until the soft tissues have somewhat recovered from the immediate effects of the traumatism?

In looking over the tables appended to this article, it will be noted that there is great diversity of practice as to the length of time allowed to elapse between the occurrence of the injury and the performance of the reparative operation. In the treatment of compound fractures of the patella, delay is injudicious. An early attempt should be made to remove or to counteract what infection has been implanted in the tissues, and adequate measures should be taken, having in view the protection of the tissues and of the articulation from septic contamination.

In all compound fractures of the patella, the time allowed to elapse between the injury and the operative intervention should be the shortest consistent with the modern surgical preparation of the operative field.

In the following compound fractures, cases 6½, 10½*p*, 25, 33, 50, 74*a*, 123, operation was performed on the day of the accident; in case 95, thirty hours after the accident.

In compound fractures of the patella, our practice is to have the patient conveyed at once to a well equipped hospital. Operation is performed soon after admission to the hospital. The operation should, if possible, be performed in a hospital, not because the operation cannot be successfully performed in a private house, but for the same reason "that a cook can make a better cake in a kitchen than in a parlor." The proper facilities are at hand.

The wisdom of operating immediately in compound fractures is, I believe, unquestioned. It is only in simple or subcutaneous fractures that there is great divergence of opinion among surgeons as to the elective time of operation, not only that, but many individual operators do not, as to the time interval between injury and operation, observe a uniform practice. In subcutaneous fractures, ample time should always be taken for the preparation of the patient, and of the surroundings, for operation.

In closed fractures, some operators operate on the day of the injury, cases 11*a*, 36, 45, 69, 108*c*, 112; others allow two days to elapse before intervening, cases 4*a*, 7, 20, 21, 92, 93; others do not operate until three days have elapsed, cases 19, 71, 82; some wait till the fourth day, cases 3, 18, 67, 70, 129; in cases 38, 39, 97, operation was performed on the fifth day. Cases 110, Bockenheimer advises that operation be performed on about the 8th day.

In confirmation of the statement that many individual operators do not always observe the same time limit, can be cited: Hamilton (cases 10½), who allows from 5 to 14 days to elapse between the injury and the operation; Mayer (cases 22) elects to operate from the 3d to the 7th day; Fowler (cases 43) from the 5th to the 14th day; Morison (cases 95) from the 1st to the 4th day; Moullin (cases 106) from the 3d to the 4th day; Doberauer (cases 86*a*) allows a few days to elapse between the accident and the operation.

It has been our practice in fresh subcutaneous fractures of the patella, to defer operation for from 3 to 5 days after the injury, being guided somewhat by the patient's general condition and also by the evidences of local trauma. The congestion and inflammatory exudate consecutive to the injury have usually by this time begun to retrogress. Our results having been satisfactory, we are averse to change.

The time interval between the day of injury and the day of operation enables the surgeon to become better acquainted with the patient's general condition, to better familiarize himself with the type of fracture which confronts him, and to better asepticize his operative field. Owing to the wrinkled, thickened nature of the skin of the front of the knee, its surgical purification presents some difficulty.

What we consider indispensable, what we consider of paramount importance, is the surgical preparation of the operative field. The success of the operation, the safety of the patient, are in a large measure dependent upon the efficacy, the thoroughness of the methods employed to attain surgical cleanliness of the operative field. Therefore, on the day of the patient's admission to the hospital, the lower half of the thigh and the upper half of the leg of the affected extremity are shaved and then mechanically and surgically cleansed. After this preliminary cleansing, a soap poultice is applied, for the night, over the prepared parts. Morning and evening, on each of the succeeding days, the parts are surgically cleansed. In the interval between the cleansings, the parts are protected from contamination by compresses of aseptic gauze, sterilized by heat. During this entire preoperative interval, all flexion of the leg on the thigh is prevented by a posterior, molded plaster of Paris splint, which maintains the thigh slightly flexed on the abdomen and the leg fully extended on the thigh. The elevation of the limb relaxes the rectus femoris muscle. The latter, by virtue of its origin above the hip joint, has a tendency to draw the upper fragment upwards. By compression exerted either by gauze or by elastic bandages, an endeavor is made to aid and to hasten the absorption of the intra- and extra-articular effusion. In operating these cases, we always use rubber gloves. All assistants, nurses included, must also employ gloves of the same material. Needless to state that the hands are prepared with the same attention to aseptic details as though we were to operate with ungloved hands. The knife used in cutting the skin is not used in cutting the deeper structures. As in our mind, the only danger of the operation is the danger of infection, and as that danger is an avoidable danger, knowingly, we run the risk of tiring the reader by enumerating details that are quite generally known. In the preparation of the field of operation, one cannot be too painstaking. Surgeons are more apprehensive of infectious complications occurring after an arthrotomy than after a laparotomy.

Whatever be the method employed, after the making of the initial incision, the least handling and manipulation of the tissues and of the articulation, the better. Even the necessary manipulations should be done in the simplest and most delicate manner. Some operators, Fowler, Hessert, etc., never allow in these cases any hand, however well disinfected, to touch the joint. By not allowing the hand, even though it be disinfected and gloved, to touch the operative wound, infection can enter the wound only through the air, the skin of the patient, or the suture material.

b. Should the operative field be rendered bloodless by the employment of an Esmarch bandage? What should be the nature of the anæsthetic employed? Local, lumbar, or general anæsthesia?

1. As a prophylactic measure against hæmorrhage, or as an aid to secure a bloodless operative field, it is rare for surgeons to make use of the Esmarch bandage, or band, in their operations for fractured patellæ. Thienger

(cases 81) and Oehlker (cases 105) employ it. Its general non-use is evidence enough that clinicians do not consider it of any great assistance in these cases.

The Esmarch's band, applied according to the ordinary rule, interferes, while in position, with the normal elasticity of individual muscles and of muscle groups, may hinder the bringing down, the pulling down, of the extensor muscles of the thigh, and consequently render difficult the approximation of the patellar fragments. The oozing into the articulation and tissues that follows its use is another undesirable feature attending its employment. We know of no valid reason for its preliminary use in operations for fractured patellæ.

Chaput (cases 32), Lotheisen (cases 65*e*) and Stimson (cases 131) have each with success, operated fractured patellæ under local anæsthesia. Chaput and Stimson used cocaine; Lotheisen employed Schliech's infiltration method. Rianzi (cases 126) in one case resorted to anæsthesia obtained by lumbar puncture and subarachnoid injection. Mickulicz in several cases used lumbar spinal anæsthesia. In case 22d, Mayer also resorted to lumbar anæsthesia.

In Chicago, in operations of this nature, in the absence of contraindications, we almost invariably use general anæsthesia. General anæsthesia enables the operator to more thoroughly protect the patient from pain, to better guard against accidental septic contamination, to secure a more complete muscular relaxation, to proceed more deliberately, to modify his procedure so as to better adapt it to the needs of the case at hand.

Perusal of the tables shows that in these operations, the employment of general anæsthesia is in accord with the practice of European and American surgical centers.

c. By what type of incision is the operator best enabled to perform the repair work which he deems appropriate and necessary?

A perusal of the tables at the close of this article shows that the type of incision employed is stated in 600 cases. In detail, the incisions used can be classified as follows:

Semilunar	Convexity outward	in	2 cases
	Convexity inward	"	4 "
	Convexity upward	"	87 "
Transverse		"	118 "
Longitudinal		in	318 cases
Horseshoe-shaped (direction of convexity or concavity not stated)		"	55 "
Crucial		"	17 "

The matter of incision is still undecided. It is a question upon which clinicians are far from being in accord, as most satisfactory results have been obtained with all the various types of incisions. Longitudinal, transverse, semicircular incisions with the convexity upward, downward, inward, or outward, have been employed. Some operators have used two short longitudinal incisions (Chaput), one at each margin of the patella. The study of the incisions employed by the various operators, leads to the conclusion that that incision which is most suitable for bony suture, is also the incision most serviceable for looping of the patella, or for suturing of the præ- and parapatellar tissues (sutures des ailerons). Large, methodically carried out incisions are infinitely less dangerous than small openings. The latter fail to fully expose the operative field, do not enable the operator to satisfactorily cleanse the joint and do not facilitate the careful repair of the lateral capsular and aponeurotic tears. Some authors (Von Bergman and Stimson) prefer a median longitudinal incision. Stimson says that he has several times used a transverse incision; this he admits, allows of more exact suturing of rents in the lateral aponeurotic expansions, nevertheless, he prefers the median longitudinal incision. Bockenheimer employs a longitudinal incision. It has been objected to the vertical incision that it gives a cicatrix exposed to pressure on kneeling, that it limits the field of operation, that it renders difficult the passage of two wires in the fractured bone, and that through it the tears in the expansions of the quadriceps femoris muscle cannot be easily reached. Of the single median vertical incision, Arthur E. Barker (cases 54) says:

"The single median vertical incision, unless it is made very long, does not admit of easy manipulation of the fragments. The freshening of the old cicatrized surfaces on both the upper and lower fragments either with saw or chisel is not easily accomplished through it; it does not admit of easy cleansing of the joint. During kneeling, the scar is in the line of pressure, and, therefore, remains tender for an in-

definite time. The 'H' shaped incision has objections. The scar lies directly across the patella."

Von Mickulicz (cases 84) and others, employed an incision transverse in direction and corresponding to the line of fracture, the length of the incision being such as to freely expose the patella and the capsular and aponeurotic tears. If a transverse incision be employed, it must not coincide with the line of fracture. It should be made either above or below the seat of fracture. In cases in which the cutaneous incision coincides with the line of fracture, the osseous cicatrix corresponds in location to the cutaneous cicatrix. Adhesion of these cicatrices to one another may occur; in case of refracture, should the cutaneous cicatrix also yield, the refracture will be compound in type. Cases of refracture of the patella are reported in which the adherent cicatrix yielding at the same time as the bone, a compound fracture resulted. We believe that the cutaneous incision should be as distant from the seat of fracture as consistent with good work. By conforming to this rule, one more surely avoids adhesion of the skin and subcutaneous tissue to the line of fracture. Further, if one should be unfortunate enough to get an infection of the soft tissues, there is less danger when the cutaneous incision is distant from the seat of fracture than when it exactly overlies it.

Hamilton (Cases 10½), who uses a flap with convexity upwards, recommends that the uppermost position of flap should not extend above the middle of upper fragment. Oehlecker in his first operations used a flap with base upward; now he uses flap with base downward. Vallas (cases 27) uses a crucial incision; the vertical portion of this begins 1 cm. above the upper border of the superior fragment and descends 1 cm. beyond the lower border of the lower fragment. The horizontal portion of this incision must extend far enough on either side of the patella to expose the acute angle which terminates the lateral tears in the capsules.

Dr. Wyllis Andrews discards all splints and casts. He reports that all his operations of late years have been by lateral suture of the torn capsular ligament after the method of Blake. With two to four stitches at each side of the broken bone, the apposition is found to be as firm as with the bone wired. He has entirely given up the use of wiring or drilling the fragments. Great use is made of the anterior fringes to support the line of fracture. This is best done by overlapping or imbricating them at the edge of the fracture line, as they seem to be too voluminous for good edge to edge union. For extra security Dr. Andrews also puts a circular suture around the whole bone, using kangaroo tendon.

With these three steps, he states that he has found a technique which has never failed in a large series of cases. He performs the operation as a routine in all healthy subjects. An element of safety against infection lies in the double line of suture. The deep closure protects the synovial cavity, so that even if stitch abscesses should occur in the skin no septic arthritis appears.

At a recent clinical meeting of the Chicago Medical Society, he showed and invited criticism of another feature of his management of fractured patella, viz.: after an operation, the discarding of all splints and casts. The cases shown were as early as two weeks, and were without any support or even dressing, passive motion being made from the first day and full voluntary motion after 6 to 8 weeks. Formerly, he used to have less motion after many weeks when the cast or splints were taken off. His claim is that any suture strong enough to withstand muscular tonicity in the quadriceps will not be broken by light passive movements, and that the massage and movements do much to hasten the repair of the fractured bone.

In operating for fractured patella, I generally employ for the exposure of the parts, a flap having its convexity downwards. The incision commences on a level with the upper margin of the patella, about one inch to one side, from here it passes downwards to a point a little below the apex of the bone, from where it is continued across the limb, and carried to a point corresponding to that from which it started. This incision does not interfere in any way with healing. Jacobson and Rowland (24*a*). It is thought that an incision with the convexity downwards, better secures the

vitality of the flap than one with the convexity upwards.

These convex incisions afford a good exposure of the parts, facilitate the removal of intra- and extra-articular exudates and extravasates, give good access to the bony fragments and allow of careful repair of all capsular præ- and parapatellar tears. If drainage of the periarticular tissues is necessary, it is easily secured. With a longitudinal incision, drainage is somewhat difficult.

d. Is it advisable in these cases to irrigate the articulation; if so, with what fluid, an antiseptic solution, irritating or non-irritating, or merely a bland, non-irritating cleansing agent, such as normal salt solution; or is the mere sponging out from the synovial cavity of the extravasated liquid and clotted blood, productive of the most satisfactory results?

Some clinicians consider the irrigation of the articulation, one of the essential steps of the operation. In about 360 of the reported cases, irrigation of the knee-joint was practiced. By some operators, an aqueous solution of carbolic acid, 2½ per cent (cases 103), 5 per cent (case 99), was the irrigating agent employed. Others made use of an aqueous solution of bichloride of mercury (cases 6½), 1-1000 solution (cases 95 *a*, *b*, *c*, *d*), 1-2000 solution (case 66), 1-8000 solution (case 69). In cases 7, 33, 36, 39, 74, 94, 102, 111, 113*a*, 118, 126, 131, the irrigating agent employed was normal salt solution. Some surgeons use plain hot water to wash out the joint (case 117). Though in these irrigated cases, good functional and anatomical recoveries were obtained, we cannot advocate joint irrigations in operations for fractured patellæ. Joint irrigation with irritating antiseptics, such as carbolic acid and bichloride of mercury, we condemn. Any agent acting as an irritant upon joint endothelium, lowers its resistance to infection, predisposes it to inflammation. In flushings or irrigations of the joint cavities with normal salt solution, which solution is in itself unobjectionable, we fail to see much value. Of what advantage can it be to waterlog the tissues?

In operations interesting the pleural cavity, we do not irrigate that chamber to secure the outflow of any effusion collected in the pleural space. To accomplish this, reliance is placed upon the elasticity of the chest-wall, the inspiratory expansion of the lung, the ascent of the diaphragm and the use of a drainage tube. In operations upon the peritoneal cavity, we do not flush this space to remove contained exudates and extravasates; we simply gently swab and mop.

In arthrotomy for fractured patellæ, we do not irrigate either the joint or the surrounding tissues. All liquid and clotted blood are removed by gauze swabs mounted on artery forceps. The sub-quadricipital synovial cul-de-sac is not overlooked, and all liquid and clotted blood therein contained is removed. The swabbing is done with great gentleness, the object being to minimize the trauma inflicted. Scrupulous care is taken to keep the fingers out of the articular cavity. In formulating our conclusion, we repeat that though we are aware that many clinicians, for instance, Ranzi, etc., prefer irrigation of the articular cavity to sponging of the articulation, we urge the discarding of joint irrigation and firmly advise for the removal of liquid and clotted blood from the articular cavity, dry sponging of the joint. Dry sponging is, in these cases, productive of more satisfactory results.

e. Should non-absorbable or absorbable suture material be used? Are there any valid reasons for discarding non-absorbable suture material?

We refer here only to buried or irremovable suture material. If the suture material be so inserted as to be removable, once organic reunion of the divided tissues has taken place, it matters little (owing to the removability of the suture material) whether absorbable or non-absorbable material be employed. For instance, Vallas, 27*a*, and others, lacking confidence in the tensile strength of catgut, doubtful of the adequate sterilization of the same, and also being unwilling to abandon foreign material in the body tissues, for the approximation of the divided tissues make use of removable metallic sutures.

In operations for fractured patellæ, buried sutures of absorbable and non-absorbable material have been and still are used. Chief among the latter are Pagenstecher's thread, silk, silkworm gut, and wire, iron, aluminum, bronze, platinum, or silver. Chief among

the former are catgut (iodinized, chromicized, kumol) and kangaroo tendon. For the approximation of the deep tissues, it is stated in the reported cases that some buried sutures of silk were used in 32 cases (cases 32, 61, 92), of silkworm gut, in 6 cases (cases 57, 125); in over 600 cases, some metallic sutures were used; brass wire being used in 30 cases (cases 84), bronze aluminum wire in about 90 cases (cases 6, 102, 110, 118); iron wire in about 40 cases (cases 113); platinum wire (case 12) was used several times. Hackenbrusch used annealed iron sutures.

Of absorbable suture material, kangaroo tendon was used in 30 cases (3, 4, 5, 21, 43, 57, 63, 71, 90, 123*b*, 128, 132). The results attending its use were uniformly satisfactory. In almost all the cases, some catgut was used, either for ligaturing or for suturing purposes. For all tissues that are to be approximated by buried sutures, we use absorbable suture material exclusively. The function of sutures is to hold divided tissues in apposition until tissue regeneration has effected organic reunion between them. The aim of the operation being to hold the bony fragments in apposition until organic union is effected, once healing has occurred, the presence of sutures in the tissues serves no useful purpose. There are still some firm believers in the employment for the approximation of the patellar fragments of metallic sutures. Among them may be mentioned Ranzi, Koerte, Lambotte (44), Lucas-Championnière. They claim to have never noticed any disturbance consequent to patellar wiring. Nevertheless, the employment of metallic suture material for the approximation of deep tissues is becoming less and less popular. The tendency of modern operators is to use absorbable suture material. Even for suturing of bone, many operators now employ catgut or kangaroo tendon (43*a*–43*b*). Cases 132, 128, 123*b*, 121, 104, 90, 79, 63, Koenig employs catgut or silk for suture of the patella and claims that it fulfills every required indication.

In fractures of the patella, it is not necessary that the fragments be held together with great firmness. Mere apposition is ample. Forcible tying of metallic sutures to some extent defeats its own purpose, as a suture drawn tight can cause in a bone, as well as in other tissues, a local pressure necrosis and absorption.

1. We consider it unwise to abandon non-absorbable suture material permanently in the articulation or in the periarticular tissues, because:

a. Clinical observation has shown that metallic sutures frequently irritate the tissues, (case 110), lower their vitality, increase chances of infection, and may require subsequent removal. Almost all of the unsatisfactory and unfortunate results (10 cases) have occurred in cases in which metallic sutures were used. Cases 60, 86*b*, 87, 92, 113, 132. In longitudinal suturing of bone, the twisted ends of the suture being almost immediately subcutaneous, kneeling is at times painful. To avoid this post-operative annoyance, some operators instead of longitudinally suturing the bone, perform transverse wiring or hemicerclage. In case 54, in later years wire causing trouble, it was removed. In case 66, the metallic sutures called for removal. One came out easily; the other broke and was abandoned in place. In case 69, three months after operation, the silver sutures on account of causing irritation and pain, were ablated. In case 76, two years after operation, one of the wires became untied. It was removed; five months later, for a similar reason, the second silver wire was removed. In cases 126, a silver wire suture escaped through an inflammatory fistula. In another case of the same series, a silver suture had to be removed. In three other cases the wires were ruptured; in another, they were undone. Other cases appear in the tables.

2. Metallic sutures may become loosened, may break, and fragments escape into the articular cavity, by which they are poorly tolerated. In cases 126, in one case, three portions of wire escaped into the articulation.

3. The embedding of wire sutures in the patella does not add to the solidity of the patella. In the following refractures, 6, 52, 55*c*, 57, 60, 73*b*, 81, 84, 90*b*, 93, 110, 113, at the time of the first fracture, the bone had been successfully wired.

Non-absorbable sutures, be they inserted transversely or sagitally, cannot be considered permanent splints. In a case reported by

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Ricard (45) a radiagram taken several months after the successful metallic suturing of a fractured patella, showed the wire to be broken. Nevertheless, bony union maintained itself. In a case 46, skiagraphed 7 years after the patella had been wired and in which a perfect anatomical and functional recovery had been obtained, one of the silver wires was broken. In Von Brunn's clinic (48), in one case the wire used for osseous suturing caused trouble and had to be removed. This led to an investigation to determine what had been the fate of the silver wire sutures used in the cases of fractured patellæ operated upon at that clinic. Twelve patients answered to a request for secondary examination. The knees were X-rayed. In three cases, the wire had gotten into the joint. In one case, the wire was broken into five pieces; in another into seven. In one case the two wires were found to be broken in eight pieces; in another it was broken in ten pieces. Von Brunn as a resume of his findings, came to the following conclusions:

1. Silver wire has not sufficient resistance to guarantee bony union of the fragments.

2. Even when the fragments are healed together, the wire may break.

3. Parts of the broken wire may wander into the articulation, or into the periarticular tissues and can excite disturbances at point of lodgment. It has been claimed by Thiem, etc., that metallic sutures suggestively hinder in some patients, the cure of the subjective troubles.

f. Shall completely detached bony fragments be removed? If completely detached bony fragments be present, their removal is one of the essential steps of the operation. It has been repeatedly done, and satisfactory results have ensued. Cases 10½*e*, 19, 50, 53, 54, 80, 81, 101, and others. The escape into the articulation of completely detached patellar fragments and their non-removal therefrom, leads to all the functional and anatomical articular disturbances inseparably associated with mobile foreign joint bodies.

g. Shall the periarticular tissues be drained? In order to allow the escape of excessive wound secretions, many clinicians, Hackenbrusch and others, though they did not resort to tube or gauze drainage of the periarticular tissues, always left the ends of the skin incision open. In our tables, it will be found stated that in cases 18, 105, 113*a*, 115, subcutaneous drainage, tube or gauze, was employed. It did not unfavorably influence the ultimate results. In clean cases, subcutaneous drainage is needless. Its employment serves no useful purpose. It retards the healing of the skin wound. Why complicate an operative procedure by a useless step?

h. Shall the articular cavity be drained? In simple fractures, no. In compound fractures, yes. The following cases of compound fractures were drained, cigarette, tube or gauze drainage being used (cases 23 (for 2 days), 33, 50, 95*a*, 99, 123*a*). Articular drainage should be discontinued as soon as the surgeon's fears as to the development of a suppurative arthritis have been dispelled. In the following cases of simple fracture (cases 60, 124, 72, 110*a*), the articular cavity was drained, in the first two series of cases for 24 hours; in the others, for a longer period. In non-infected cases, if the operator has conducted an aseptic operation and if the hæmostasis of the operative wound is satisfactory, drainage is superfluous, is more harmful than helpful. In compound fractures, we are dealing with presumably infected wounds (in fact all wounds not inflicted by the surgeon must be so considered) therefore in them, drainage, from the standpoint of prophylaxis, meets an indication.

The modern tendency is to employ drainage only in the presence of absolute indications; and to discard it, when in doubt, as to its utility in the case at hand. When unneeded, drainage instead of contributing to rapid aseptic healing, has a tendency to act as an irritant. In the etiology of inflammation, irritants are considered predisposing and exciting factors. We have not as yet operated on a case of subcutaneous fracture of the patella in which we have either drained the articular cavity or the periarticular tissues.

1. What should be the duration and the nature of the post-operative treatment? As yet, the practice of the different operators as to nature and duration of post-operative treatment is most dissimilar. The reader will convince himself of the truth of this statement by perusing the tables. Some believe in pro-

longed immobilization; others, such as E. Wyllis Andrews, do not immobilize in these cases. We proceed as follows: Immediately after the operative procedure and the application of the protective dressing to the wound and while the patient is still anæsthetized, moulded plaster of Paris splint is applied to the injured extremity. This splint should be amply padded, should cover the posterior and lateral surfaces of the limb and should extend from about 10 cm. above the external malleolus to the gluteal fold. The object of this splint is to immobilize the extremity in the position of full extension of the leg on the thigh, and of slight flexion of the thigh on the abdomen. The slight flexion of the thigh on the pelvis has for its purpose the relaxation of the rectus femoris muscle. During the patient's confinement to bed attention must be given to the heel and to the toes. So as to avoid the development of a pressure-sore upon former, the heel should be protected by a doughnut pad or other means. By the use of a "cradle" the toes will not be subjected to the weight of the bedclothes and talipes decubitus will not ensue. In the absence of a marked elevation of temperature, of intense pain, of saturation of the dressings, the protective gauze dressings on the joint remain undisturbed for from 10 to 15 days, then, if indicated, the removable sutures are ablated. The immobilizing splint is kept in position for about a month.

Kausch (case 118), unlike the vast majority of operators, does not put up the leg in the extended position. He maintained the leg in a position of flexion of 100 degrees. Flexion of the leg on the thigh increases the tension on the sutures, and tends to separate the patellar fragments and the margins of the other divided or lacerated tissues. As to the use of massage so highly recommended by many clinicians, our personal experience with it is too limited to warrant the expression of an opinion. As to the duration of immobilization, the practice of the various operators is far from being in accord. Rigby allows his patients out of bed on the 14th day. Quénu does not allow them to leave their bed before the 25th day. Lucas-Championnière considers prolonged immobilization a "detestable method." Lejars suppresses all immobilization on about the 10th day after the operation. Moullin allows patients to start walking during the third week. Berger begins mobilization of the knee on the 15th, 18th, 20th, or 25th day. Schwartz does not allow flexion of the knee previous to the 25th day. The first motions of the patella should be lateral motions. We do not begin flexion of the leg upon the thigh previous to the expiration of one month from the day of the operation. The first attempts at flexion should be cautiously made. With use, the range of motion gradually increases; in many cases, the restoration of joint function is complete. When flexion to a right angle has been recovered, the patient is discharged from further observation.

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	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
1. Rosenberger. Wuerzburg) Revue de Chir., Paris, 1899, vol. 19, p. 120. Demonstration. Also Verhandlungen der Deutschen Gesellschaft für Chirurgie, 1898, vol. 27, Heft 1: p. 155.	Male.	8 months.	21 months before fractured his patella. Nine months later, refractured same. Lower limb much atrophied. Patient is unable to work. Separation between fragments 7 cm. Quadriceps atrophied and marked retracted.	Longitudinal incision extending from junction of lower and middle third of thigh, to just below the tubial tubercle. Patellar fragments exposed. 1 cm. above the insertion of quadriceps tendon operator carried his incision transversely midway between anterior and posterior surfaces of quadriceps extensor femoris to base of the patella. The patella was then sawn transversely at an equal distance between its anterior and posterior surfaces to the beginning of the fibrous callus. The same procedure was repeated upon the ligamentum patellæ and the inferior fragment. The osseous flaps were turned toward each other in such a way that the tendinous tissue taken from the quadriceps extensor femoris and that from the patellar ligament were in juxtaposition and sutured to each other. Healed by first intention.	Patient was discharged in six weeks. He works in the field. Can flex his knee to an angle of 70°.
2. Vincent, M. T. Jackson. Brit. Med. Jour., 1900, vol. 1, p. 447.	Male, 52 yrs.		Transverse fracture of left knee.	Longitudinal incision. Clots and loose pieces of aponeurotic tissue were removed from the articulation. Joint washed out. Silver wire sutures were made to encircle both fragments longitudinally by being passed beneath them three times. After fragments had been approximated, the metallic ligatures were twisted and then cut off.	6 months after operation patient could walk well and power to flex joint was increasing.
3. Barr, H. A., Am. Jr. Sur. & Gyn., St. Louis, 1900, vol. 14, p. 29. Demonstration.	Male, 30 yrs.	4 days.	Slipped on pavement. Transverse fracture of left patella. Two inches separation of fragments. The blood clots and the bone exudate covering the fractured surfaces were one-quarter of an inch in thickness.	The fractured surfaces were freshened with the aid of a curette. The fragments were then drawn in apposition by kangaroo tendon. Tendon was not passed through the bony part of the fragments, but through their tendinous attachments above and below. Drainage.	Recovery. Four months after operation had almost recovered complete use of limb.
4*a*. Fiaschi, T, Australasian Med. Gazette. Sydney, 1903, vol. 22, p. 345. Case II. Ferraresi's method for the treatment of fracture of the patella.	Male, 49 yrs.	Next day.	While walking down hill he stumbled on making an effort to recover himself, he felt a snap in his knee and fell with his limb useless.	Ferraresi's method: *a*. Tendinous flap about 2 mm. dissected from quadriceps m. and folded down over fractured patella. *b*. Looped suture attaching free edge of flap to ligamentum patellæ. *c*. Sutures bringing together edges of gap. Kangaroo tendon and catgut sutures.	One month after operation, splint and dressings were removed. Osseous union. Good result.
4*b*. Same reference as 4*a*. Case 1.	Male.		Direct violence. Transverse fracture.	Same method as 4*a*.	Within three months, patient was able to walk up and down stairs and flex the knee easily to a right angle. Osseous union.
5. Bogart, A. H., Brooklyn Med. Jr., 1903 vol. 17, p. 81. Demonstration.	Male, 41 yrs.	14 days.	In jumping from a height of 15 feet, patient twisted his leg. Could not walk. Transverse fracture of patella. One inch separation.	A considerable quantity of clotted blood was removed from the joint cavity. The fringe of prepatellar tissue which had fallen between the fragments was also removed. Approximation of fragments was effected by two kangaroo tendons. Immobilization of joint for six weeks.	Result perfectly satisfactory. Very slight limitation of motion.
6. Lejars., Gazette Des Hôpitaux, Paris, 1903, vol. 76, p. 411. Demonstration.	Male.		Patient has fractured his right patella twice before. Each time, it was wired successfully. This fracture involved the left patella. It was transverse. The lower fragment was very voluminous.	Hemi-cerclage. (Procédé de Quénu). Bronze aluminum wire. Early passive motion.	Got up 12 days after operation. 18 days after operation, presented to the Societe de Chir. de Paris. Perfect result.

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6½. Lamb, J. H., Lancet, London, 1901, vol. 1, p. 1398. A case of compound fracture of the patella and traumatic dislocation of the knee.	Male, 60 yrs.	Same day.	Patella cut in two by a scythe. Synovial sac open and internal ligament was divided for about half of its extent. Ext. Lat. lig. completely severed.	No drill being obtainable, the divided edges of the patella were drawn together by wire sutures. These were passed from below upwards through the ligamentum patellæ and through tendon of the quadriceps extensor. Joint washed with sublimate solution. Tears in ligament and joint capsule repaired.	Three weeks after the operation, the wire sutures were removed. A month after the operation patient could walk.
7. Rodman, W. L., An. of Surg., 1902, vol. 36, p. 145.	Male, 40 yrs.	2 days.	Fracture of the patella. Joint filled with blood clots.	Irrigated joint cavity with normal salt solution. Wired by placing the wire through the fibro aponeurotic covering of the bone. No bone suture.	Recovery uneventful.
8. Fowler, R. S., Brooklyn Med. Jour., 1902, vol. 16, p. 408.	Male.	10 days.	Transverse fracture of the patella.	Internal curved incision. Circular and through and through suture of the patella.	In three weeks patient began to walk. Two months and seven weeks after operation patient resumed his work as stableman. Result excellent.
9. Schanz, A., Muench. Med. Woch., 1903, vol. 50, p. 1293. Eine neue Operation fuer Behandlung veralteter Knie scheibenbruche.	Male, 25 yrs.	5 yrs.	Right patella. Fragments of patella 12 cm. apart could be brought together to about 10 cm. Reserve extensor apparatus completely ruptured. Functional disturbance similar to paralysis of quadriceps extensor fem. muscle.	Incision from insertion of Sartorius to middle thigh. Sartorius laid bare lifted from its bed without separation of its insertion. Longitudinal groove, made in patellar fragments in which the Sartorius was embedded, Sartorius fixed with wire to bone and also sutured to interfragmentary fibrous callus. No drainage. Immobilization in extended position. Sutures removed in two weeks.	Six weeks later, complete normal function.
10. Guyot, J., Gazette hebdomadaire des sciences médicales. Bordeaux, 1906, vol. 27, p. 523. Quelques considerations de technique opératiore á propos dún casde suture secondaire, de la rotule après resection d'un long cal fibreux.	Male, 25 yrs.	14 yrs.	In early life, patient fractured his left patella. Expectant treatment. Walked at end of three and one-half months. After 14 years owing to long-continued and increasing difficulty with the knee, he was admitted to hospital. Marked atrophy of the left thigh. Two fragments are separated by 6 cm. interval.	Vertical incision 10 cm. long. Fibrous callus removed. Patellar fragments freshened with saw. Osseous metallic suture. Also circumferential metallic suture. Soft tissues sutured with catgut. At end of one month, prudent passive motion was begun.	At the end of three months, there was still some articular stiffness. At end of a year could go up and down stairs. Could walk and run without undue fatigue and without pain.
11. Ball, Chas. B., The Practitioner, 1898, vol. 60, p. 483. Treatment of the fracture of the patella by a steel wire rope.	Female, 18 yrs.	6 months.	Fell into a ditch. Fragments showed separation of 4 inches. Patient had no power to extend knee and was seriously crippled.	Open operation. Circumferential wire rope. Horseshoe flap. Back splint. Periosteal flaps sutured together over the line of fracture.	Excellent result. In a month was able to walk fairly well.
10½*a*. Hamilton, G. G., Edinburg Med. Jr., 1906, vol. 61, p. 206.	Male, 29 yrs.	14 days.	Fell off a cart onto his knee. Transverse fracture.	Open method transverse wiring. No suppuration. Allowed to move knee 8 days after operation.	Bends knee to a right angle. Bony union.
10½*b*.	Male, 41 yrs.	8 days.	Slipped in room and fell in sitting position. Transverse fracture. A good deal of loose tissue between the fragments.	Open method transverse wiring. Allowed to move the knee joint on the 17th day after the operation.	Bony union. Bends knee to a right angle.
10½*c*.	Male, 26 yrs.	12 days.	Slipped when jumping. Transverse fracture. Large piece of tissue covered with blood clots bulged into the knee joint. Much blood in joint.	Open method transverse wiring. Allowed to move joint on 19th day after the operation.	Bony union. Following his profession as an acrobat.
10½*d*.	Male, 24 yrs.	9 days.	Violent twist at football. Transverse fracture.	Open method transverse wiring. Allowed to move the knee joint on the 18th day after the operation.	Bony union. Bends knee joint to a right angle.
10½*e*.	Male, 15 yrs.	9 days.	Fell from a scaffolding on both knees. Right knee was broken in three pieces. In the left knee, a piece was found turned into the joint. It had to be removed.	Transverse wiring. Allowed to move the joint on the 18th day after the operation.	Bony union. Follows usual employment.

10½*f*.	Male, 43 yrs.	7 days.	Slipped. Transverse fracture. Right knee joint inflamed, tender and full of blood.	Transverse wiring. Movement allowed on the 12th day after operation.	Bony union. Resumed his work, that of hod-carrier.
10½*g*.	Male, 28 yrs.	One and a half months.	Fell and struck knee against iron stanchion. Firm adhesions between patella and femur.	Transverse wiring. Movement allowed on the 19th day after operation.	Bony union. Useful limb. Wire in position.
10½*h*.	Male, 35 yrs.	14 days.	Horse kicked him on left patella. Stellate fracture, 7 pieces.	Brad awl used. Wire passed through the quadriceps tendon and ligamentum patellæ in such a way to encircle fragments. Two silk sutures over top of patella. Movement allowed on 12th day after operation.	Bony union. Bends joint to nearly a right angle. Wire still around the fragments.
10½*i*.	Female, 41 yrs.	13 days.	Foot caught and fell down three stairs. Transverse fracture. Much hemorrhage into the tissues. Organized blood in the knee joint.	Transverse wiring. Movement allowlowed on the 12th day after the operation.	Bony union. Bends joint to nearly a right angle.
10½*k*.	Female, 23 yrs.	5 days.	Fell down cellar steps. Transverse fracture. Two fragments.	Transverse wiring. Movement allowed on the 10th day after the operation.	Bony union. Can move joint to an acute angle.
10½*l*.	Male, 23 yrs.	15 days.	Fell from loft 10 ft. high. Three fragments. Blood and a small splinter of bone in joint cavity.	Transverse wiring. Movement on the 10th day after the operation.	Bony union. Can bend joint to an acute angle.
10½*m*.	Male, 49 yrs.	7 days.	Missed a kick at a dog. Transverse fracture. Three fragments ¼ inch separation.	Transverse wiring. Movement allowed on the 19th day after the operation.	The left patella had been broken over a year ago and treated expectantly. The patient claims the right patella to be as good after a month as the left after 18 months.
10½*n*.	Male, 64 yrs.	11 days.	Fell off a tram-car. Transverse fracture. ½ inch separation.	Transverse wiring. Movement allowed on the 10th day after operation.	Died of apoplexy.
10½*o*.	Male.	9 days.	Fell from a coal wagon. Three fragments. As eyeball was suppurating, operation was postponed.	Transverse wiring. Movement allowed on the 19th day.	Bony union.
10½*p*.	Male.	Same day.	Motor fire engine collided with wall while this officer was on it. Compound fracture. Many fragments.	Transverse wiring. Movement allowed on the 12th day after the operation.	There was superficial stitch trouble probably due to autoinfection.
11*a*. Fredet, Pierre, Demicerclage de la rotule par le procédé de Quénu Bulletins et Mémoires de la Société Anatomique de Paris. 1903, 128é anneé., p. 474.	Male, 59 yrs.	Same day.	Transverse. 5 fragments.	Open operation. A silver wire loop suture was passed transversely through the upper fragment and then through the ligamentum patellæ, in immediate contact with the border of the lower fragment. Ends of wire twisted over outer border of patella.	Anatomically and functionally perfect.
12. Berger, Bull et Mem. de la Soc. de Chir. de Paris, 1899, vol. 25, p. 780. 3 patients. Demonstration.				Patella circumferentially looped. In two cases, silver wire was used. In one case, platinum wire.	Osseous union. X-ray test. First two patients had complete extension and were able to ascend and descend stairs without any difficulty and without an observer being able to detect which limb had been fractured.
12*b*. Demons. Gazatte Hebdomadaire des Sciences Médicales de Bordeaux, 1898, vol. 19, p. 333.	Male.		Refracture.	First fracture circumferential treated expectantly, looping of patella. Patient left hospital with silver wire, apparently cured. Returned shortly afterward with a refracture, open operation. Callus from former fracture cases, consisted solely of fibrous tissues.	Two months after patient was doing heavy farm work.
13. McWilliams, Clarence S., Medical Record, N. Y., 1907, vol. 71, p. 748. Demonstration.	Male.	12 days.	Fell. Walked one block and fell again. X-ray showed patella to be fractured in 5 or 6 fragments. Had two infected skin wounds. Operation therefore delayed.	Transverse incision. 3 loose pieces of bone removed from joint. Joint cleaned. Purse string suture around remaining fragments, as well as vertical one. Careful suturing of tears in vast expansion.	Immobilized 21 days. Patient walked out on 28th day. Good result.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
14. Batut, Revue de Chir. Paris, 1900, vol. 22, p. 113. Fracture ancienne de la rotule. Suture et cerclage. Case 1. Case 2. Fell.	Male, Soldier.	4 months.	Absolute loss of function. Interval between fragments, two fingers' breadth. Great difficulty in maintaining fragments in apposition. Seven fragments.	Interfragmentary fibrous tissue was removed. First, a circumferential metallic suture was introduced. It broke. Then a second one was inserted. It could not keep the fragments in contact. Bone was then sutured. Cerclage.	8 months after, extension was complete. Flexion limited to a right angle. Good.
15. Schwartz. Bull. et Mem. de la Soc. de Chir. de Paris, 1900, vol. 26, p. 177. Demonstration.	Male.	3 weeks.	Indirect fracture of patella with lesions of the integument and sanguinous infiltration of the tissues. Separation of fragments about 3 cm.	Joint was opened and blood clots removed. Circumferential suture of patella. Silver wire used. On 20th day passive movement of limb.	Patient is a park policeman and has full use of knee. Flexion possible beyond right angle. The patella is increased in size in all its diameters.
16. Arrou. Bull. et Mém. de la Soc. de Chir. de Paris, 1900, vol. 26, p. 597. Demonstration.	Female, 32 yrs.	48 hours.	Right patella. Separation of fragments 2 cm.	Cerclage made with silver wire. Four sutures of catgut were passed through the fibrous tissues.	18 days after operation patient walked. Flexion is not complete yet. It is still increasing. Walking is painless.
17. Cassedebat, P. A., Arch. Gen. de Méd., Paris, 1901, N.S.V., p. 46. Du traitement des fractures de la rotule par le cerclage.	Male, 23 yrs.		Fell with his horse. Left knee, compound fracture. patella fractured in 7 fragments unequal in size. The projection of the fragments above the normal level of the bone could be easily palpated.	Horseshoe incision around lower fragment. Circumferential silver wire suture. Suturing of torn patellar ailerons, of prepatellar fibro-periosteal tissues and of aponeurosis.	Recovery.
18. Dentu, L., Bull et Mém. de la Soc. Anatomique de Paris, 1901, vol. 3, p. 442, M. Paul Delbet, Cerclage de la rotule.		4th day.	Misstep, fell upon knee and fractured patella. Fragments separated by an interval of 1½ cm. Large quantity of blood in joint. Lower fragment divided in halves. Absolute impotency of limb.	Circumferential suture with silver wire. Prepatellar fibrous tissues sutured with catgut. Skin sutured. Subcutaneous drainage.	35 days after operation, left hospital. Only slight stiffness in knee. Five months after the knee was skiagramed. Wires were in place and well tolerated. It was impossible to detect the slightest solution of continuity in the bone or to detect the slightest deviation of the fragments.
19. Rigal, Lyon Méd. 1903, vol. 101, p. 1096. Un cas de fracture de la rotule.	Male.	3 days.	Patient fell on knee from a trapeze. Fractured left patella. Patient in bad physical condition. Three fragments. Manifest separation between fragments of over 2 cm.	Operation without anesthetic. Horseshoe shaped incision over point of fracture. Intra articular lavage with boiled water. The third fragment was so small that it was extirpated. Exact coaptation of remaining fragments by catgut suturing of fibroperiosteal structures. Skin sutured with silkworm gut. Posterior plaster of Paris splint. On 15th day, massage and passive motion. 45 days after operation, recovery complete.	In this case the contour of the knee is absolutely normal. Trace of seat of fracture cannot be found. Motion of joint is painless and patient has normal range of movement.
20. Walthier. Bull. et Mém de la Soc. de Chir. de Paris. 1903, vol. 29, p. 512.		2 days.	Transverse fracture. Fragments nearly equal in volume.	Fractured edges of fragments were cleared of fibrous tissues and freshened. Cerclage with silver wire, 11mm. in diameter. The ailerons were sutured with catgut. No drainage.	Good result.
21. Fowler, Russel P. Med. News, 1903, vol. 82, p. 592.	Male, 39 yrs.	2 days.	Transverse fracture 1½ inches separation. Capsule completely ruptured. Torn parts overlapped fractured surfaces of fragments.	Fragments held in apposition by circumferential sutures of kangaroo tendons. Capsule sutured with same material. On 10th day dressings removed. Passive movement instituted. Massage. The knife used in cutting the skin is not used for cutting deeper structures.	On 18th day walked unaided.
22a. Mayer. Brussels, Verhandlung der Deutschen Chirurgischen Gesellschaft, 1905, vol. 34, p. 186.	a. Female, 40 yrs. b. Male, 53 yrs. c. Male, 41 yrs. d. Male, 51 yrs.	5 months. 3 days. 3 days. 7 days.	Diastasis, 1½ cm. Diastasis, 3½ cm. Diastasis, 5 cm. Diastasis, 2 cm. Left patella.	Catgut suture of fibrous capsule and ligaments. Cerclage. Cerclage. Rachococainisation, cerclage.	Patient perfectly cured. Perfect result. Joint perfectly normal. Normal function. Osseous union.

	e. Male, 53 yrs.	3 days.	Diastasis 5 cm. Right patella.	Cerclage.	Healing perfect.
	f. Male, 24 yrs.		Left patella.	Cerclage.	Complete restoration of function.
	g. Female, 46 yrs.	6 days.	1 cm. diastasis. Lower fragment was completely inverted.	Cerclage.	Completely recovered.
	h. Male, 29 yrs.	3 days.	Patient fell from wheel on right knee.	Cerclage.	Knee completely normal.
	i. Male, 30 yrs.	4 days.		Cerclage.	Flexion of knee to 90 degrees.
	k. Male, 25 yrs.	4 days.	3 cm. diastasis.	Cerclage.	Walks well. Flexion to 90 degrees.
	l. Female, 30 yrs.		Patient fell on her back. Heard a cracking in right knee.	1½ cm. Diastasis. Cerclage.	Patella freely movable.
	m. Female, 39 yrs.		Fell upon left knee. Was assisted up, but fell again, this time on right knee. Was treated inoperatively for six months. No attempt at union.	Bilateral fracture. Diastasis right patella. 5 cm. Diastasis left patella 7 cm. Fractured surfaces freshened. Patella looped and in addition fragments sutured by one wire suture.	30 days after walked. Normal flexion to 90 degrees. Very satisfactory result. Flexion to 90°.
	n. Female, 35 yrs.		In trying to keep her balance, fractured her right patella. Had had in early life resection of left knee.	Diastasis 3 cm. Cerclage.	Perfect coaptation.
23. Harrington, C. D. Northwestern Lancet, 1905, vol. 25, p. 50. Compound comminuted fracture of patella.	Male.		While riding a wheel collided with a freight car. Compound comminuted fracture of the left patella. X-ray. 8 fragments.	Open operation. Silver wire passed around the fragments and through the tendons to maintain reduction. 2 days drainage.	Full recovery. Motion all that could be desired. Radiograph 5 yrs. and 3 mos. after operation shows silver wire to be intact. It has caused no trouble.
24. Carson, H. W. The Med. Press, London, 1905, vol. 131, p. 381. Operation for fractured patella with absorbable sutures.	Male, 28 yrs.		Caused by muscular action in diving from a spring board. Right patella.	Vertical incision. Both fractured surfaces were covered with a tough layer of aponeurosis. Joint cleared of blood clots. A double suture of 40 day catgut was passed around the patella through the superficial layers of the aponeurosis expansion beginning from below passing right around and finishing like a purse string. Prepatellar tissues sutured.	Passive movement on 10th day. Three weeks after patient was walking without a limp. Patella was firmly united.
25. Scannell, D. D. Boston M. & S. J., 1906, vol. 16, p. 568. Compound fractures of the patella. Report of unusual cases.	Male, 63 yrs.	Immediately.	Fell seven feet down an elevator shaft. Wound in right knee 5 inches long. Comminuted fracture of the patella could be felt. Anterior cartilage of condyles scooped off as if by a gouge. Cavity thoroughly irrigated before suturing of tissues.	Purse string sutures of chromocized catgut (number 3) was passed around the patella and through the ligamentum patella and the tendon of the quadriceps femoris.	After four months, normal flexion and extension.
26. Viannay, M., for M. Vallas, Lyon Med. 1898, vol. 88, p. 589. Suture de la rotule.	Male, 42 yrs. Right patella.	1 year. Almost complete functional impotency of right limb.	First time in the hospital 2 months. Next time not stated. Fracture produced by direct cause. Had been treated twice before by non-operative treatment. Fragments separated by three fingers' breadth.	Resection of fibrous bond of union. Mobilization and freshening of the patellar fragments. Suture of the prepatellar fibro-periosteal tissues. Also careful suturing of accessory patellar ligaments.	Satisfactory result.
27*a*. Vallas. Revue de Chir., Par., vol. 20, p. 419.	Male, 40 yrs.	3 days.	In effort to recover balance, he sustained a transverse fracture of patella. Fell — walked twenty metres during which he fell twice.	Crucial incision. Suture of soft fibrous tissues with catgut. Suture of skin with metallic sutures.	Forty days after patient could walk with the aid of a cane. Was seen sometime after, all articular stiffness has disappeared. Motion is normal.
27*b*. Vallas. Revue de Chir., Par., 1899, vol. 20, p. 419.	Male, 27 yrs.	2 days.	Interval between fragments 4 cm. The articular capsule and the ailerons were torn as far back as the femoral condyles.	Suture of the soft tissues. Plaster of Paris splint applied.	Absolute integrity of the joint. Restoration of joint function complete.
27*c*. Vallas. Revue de Chirurgie, Paris, 1899, vol. 20, p. 419. Traitment des fractures de la rotule par la suture de la capsule.	Male, 42 yrs.		Fractured patella. One year previously was treated by non-operative measures. After two months' stay in bed, fragments were separated by three fingers' breadth interval. Complete impotence of limb. Massage and douches were then used. No result.	Crucial incision. Resection of fibrous callus. Freshening of fractured surfaces. Suturing of soft tissues.	Excellent result.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
27*d*. Vallas. Revue de Chir. Par., 1899, vol. 20, p. 419. (See illustration in this article of the technique of suturing of the ailerons.)	Male, 70 yrs.	3 days.	Fell from a wagon and fractured left patella. 26 years before had fractured this same patella. Expectant treatment had been followed by healing with long fibrous union. Since fracture limb had never been very strong. Three fragments. Separation, three fingers' breadth. Large tear of capsule.	Suture of soft parts. Immobilization for 30 days.	40 days after operation could walk without crutches. Could flex limb to a right angle.
27*e*. Vallas. Revue de Chir., Par., 1899, vol. 20, p. 419.	Male, 33 yrs.	4 days.	Transverse fracture of the patella. Fragments separated by three fingers' breadth. Limb absolutely impotent. Capsule much lacerated on each side of the patella.	Vallas method.	25 days after could walk with crutches. The joint eventually recovered its full functional integrity.
28. Albertin. Lyon Med. 1899, vol. 92, p. 59. Fracture de la rotule traitée par la méthode de Vallas.	Male, 48 yrs.	4 days.	Fell and fractured patella. Bony fragments separated by three fingers' breadth. Hæmarthrosis. The tear of the lateral patellar structures extended as far back as the junction of the lateral and posterior surfaces of the knee.	Arthrotomy. Ten catgut sutures in each ailerons. Four catgut sutures in the prepatellar fibro-periosteal tissues. Skin sutured. No drainage. Posterior plaster of Paris splint. Sutures were removed on the 14th day. On the 15th day, massage was begun. On the 30th day, the patient began to walk on crutches.	Result: Knee anatomically and functionally perfect.
29. Vallas. Lyon Med., 1899, vol. 91, p. 414. Demonstration.			Separation of 3 cm. between fragments.	Suture of the ailerons.	Perfect results. It is not possible to recognize that there has been a fracture.
30. Ruotte. Revue de Chir. de Paris, 1901, vol. 23, p. 293.			Transverse fracture.	Suture of the fibro-periosteal prepatellar tissues and of the accessory patellar ligaments.	Perfect bony union.
31. Battut. Revue de Chir. de Paris, 1901, vol. 23, p. 292. Fracture de la rotule. Suture tendino-periostique. Demonstration.	Male, Soldier.		Fell down stairs. Transverse fracture of patella. Laceration of capsule.	Suture of the prepatellar fibro-periosteal tissues and ailerons. No suture of bone At end of 35 days, passive motion of the knee joint.	Flexion and extension the same in both limbs.
32. Chaput. Bull. et Mém. de la Soc. de Chir. de Paris, 1901, vol. 27, p. 345.	Male.		Transverse fracture of patella. Distance between fragments about 3 cm.	Local cocaine anæsthesia. Two vertical incisions 4 and 5 cm. in length were made at sides of the patella so as to expose the tear in the ailerons. The fractured surfaces were freshened with a sharp curette and freed from blood clots, etc. Each aileron was sutured with two stitches of silk and the skin incisions were closed with silkworm gut.	Wound healed by first intention. The man commenced to walk on the 30th day. Extension of limb good, but flexion is still slightly limited.
33. Modlin, J. G. British Med. Journal, 1901, vol. 1, p. 826.	Male, 28 yrs.	At once.	Due to direct violence. Compound comminuted fracture of the left patella. The patella was diagonally fractured. The outer one-third remaining intact. The rest was broken into eight pieces, five of which were inside of the joint. Quadriceps extensor and the ligamentum patella as well as the periosteum were extensively lacerated.	Completely detached bone. Fragments were removed. Periosteum and quadriceps tendon sutured with catgut. Joint irrigated. Drainage. Leg dressed on posterior splint for three weeks, when passive motion was begun.	Complete recovery. No impairment of joint. Patient walks without a limp and can cycle as well as before the accident.
34. Erdman, J. E. Annals of Surg., 1900, vol. 32, p. 709. Demonstration.	Male, 22 yrs.	10 days.	Fell from a wagon. Transverse fracture of right patella. Patella broken in six pieces. Distance between the two main fragments one inch. The distal and proximal fragments were each fractured into three pieces.	Longitudinal incision. Prepatellar fascia and capsule were united by catgut longitudinally and transversely, so as to cause perfect apposition of the parts.	Two months later patient was discharged. Movement nearly normal.

35. Tenderich Deutsche Zeitschrift für Chir., 1900, vol. 56, p. 573. Ein weiterer Vorschlag zur Behandlung veralteter ungeheilter Patellar brüche.	Soldier, Right patella.	6 mos. after refracture.	In Aug., 1898, fractured by kick of horse. In Nov., 1898, patella refractured. In May, 1899, impossible to extend lower leg. Effusion in knee. Fragments 10 cm. apart. Circumference of right thigh 21 cm. less than left.	Non-operative treatment. Operative treatment. Horizontal incision. Tissues between fragments removed. Fragments were soft so that a medium pull on the silver wire cut into them Rent in capsule was sutured and lateral parts of quadriceps extensor muscle brought to insertion on the tibia.	No result. In May. 1900, patient walks without difficulty, rides bicycle 30 km. without tiring. Still improving. The fragments are 8½ cm. apart. By pressure this distance can be lessened to 4 cm.
36. Warren. Boston Med.. & Surg. Journal, 1900, vol. 142, p. 276. Demonstration. Fresh fractured patella sutured with catgut through the periosteum.		One hour.		Curved incision below patella. Washed out the joint thoroughly with hot salt solution. Sutured the capsule with chromicized catgut.	Wound healed by first intention. In three weeks, passive motion and massage were begun. In six weeks, patient walked alone without crutches. Was able to bend the knee to a right angle.
37. Durand. Lyon Med. 1901, vol. 97, p. 883. Fracture ancienne de la rotule; restauration des ailerons sans suture osseuse.	Male, 39 yrs.		Patient fell. Fracture due to muscular contraction. Separation between fragments about 2 cm. First tried immobilization for 60 days. No result. Immobilized again for 30 days. A month later, removed immobilizing apparatus.	At the time of operation, the interval between the fragments was 6 cm. Resection of partial cicatrix. The suture of the ailerons was made with strong catgut. No osseous suture. It was necessary to divide some connective tissue bands before the freshened fractured surfaces of the bony fragments could be brought into exact apposition.	Excellent result functionally.
38. Vallas. Lyon Med. 1902, vol. 99, p. 883. Demonstration.		5 days.	Fracture of patella. Interval between fragments 3 cm.	No osseous sutures. Suture of ailerons and of capsular tears.	Excellent results.
39. Gayet. Lyon Med. 1902, vol. 98, p. 949.	Male, 46 yrs.	5 days.	Misstep, fell on left knee. With difficulty hobbled a distance of 120 meters to reach his home. Bony fragments separated by an interval of 2 cm. Marked hæmarthrosis complete loss of function of quadriceps extensor femoris.	Ailerons torn. Fragments separated by an interval of 2 cm. Fractured surface of lower fragment looks forward. Blood clots irrigated out of joint. Three catgut sutures on each aileron. Three catgut sutures on prepatellar fibro-periosteal sutures. Skin sutured with catgut.	Removed stitches on 10th day. On 15th day massage. On 21st day first attempt at walking excellent.
40. Eisendrath, D. N. Ill. Med. Jour., Springfield, 1903, N. S. vol. 4, p. 736. Fracture of the patella with suture of the aponeurosis.	Male.		While intoxicated fell backward down 10 or 12 steps. Patella torn in two parts. Aponeurosis had been turned in at the edges of the fracture. The fascia, the periosteum and the aponeurosis were turned in a typical manner between the edges of the fracture.	Bone not sutured on account of drill not working. Sutures were passed through the aponeurosis on both sides of the patella and two sutures were passed through the periosteum of the patella itself.	Functional result all that could be desired. X-ray picture taken six weeks after accident showed no separation of fragments.
41. Kevin. Brooklyn Med. Jr., 1903, vol. 17, p. 81. plaster of Paris. Demonstration.	Male.	10 days.	Struck patella against car step, fracturing it. Discovered uselessness of leg immediately after.	Arched incision. Fibrinous material and blood clots removed. Capsule sutured. Plaster of Paris dressing removed at end of 9 days.	Five weeks after operation was able to walk with comfort.
42. Moschowitz. Medical Record, N. Y., 1904, vol. 66, p. 1036.	Young man.			Fell 4 stories. Fracture of patella. Lower fragment was no larger than the finger tip. Some separation. Small fragment sutured to patella.	Result perfect.
43*a*. Fowler. Med. News, 1903, vol. 82, p. 592.	Male, 60 yrs.	8 days.	Right patella 2½ in. diastasis. Immediate disability. Fracture in middle transverse line. Upper fragment tilted forward. Its fractured surface covered with torn capsule.	Kangaroo mattress suture of the quadriceps and ligamentum patellæ applied in front of patella to overcome the tilting and give perfect apposition to fragments.	Patient walked on 30th day. Four months after operation functional result perfect.
43*b*. Fowler. Med. News, 1903, vol. 82, p. 592.	Male, 42 yrs.	10 days.	Fell upon flat surface. Right patella.	Curved internal incision. Right patella torn capsule interposed between fragments. Capsule sutured through and through with kangaroo tendon.	On 40th day, walked unaided. In 96 days perfect functional result had been obtained.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
43c. Fowler. Med. News, 1903, vol. 82, p. 592.	Male, 38 yrs.	10 days.	Left patella fractured transversely by a fall on a flat surface. Diastasis 1½ in. Complete rupture of capsule.	Interrupted sutures of capsule with kangaroo. Massage and passive motion on 10th day. Active movement on 14th day.	Patient walked unaided on 16th day. 2 weeks later perfect functional results.
43d. Fowler. Med. News, 1903, vol. 82, p. 592.	Male, 35 yrs.	10th day.	Fell against curbstone. Fracture of left patella.	Capsule sutured with interrupted kangaroo tendon.	Patient walked on 24th day. Good bony union.
43e. Fowler. Med. News, 1903, vol. 82, p. 592. The operative treatment of fracture of the patella.	Male. 37 years.	14 days.	Fell against curbstone. Simple transverse fracture. Disability immediately. Two inches of separation of fragments.	Curved internal incision. Torn edges of capsule interposed between edges of the fragments. Upper fragment twice the size of the lower. Prepatellar bursa involved. Edges of the torn capsule united by interrupted sutures of kangaroo tendon.	Bony union. Perfect functional result.
44. Bullett. Amer. Med., 1903, vol. 5, p. 211. Treatment of fractures of the patella.	Female.	10 days.	Both patellæ snapped as patient was endeavoring not to fall. Transverse fracture of both patellæ.	No wire to hold the fragments. Closed torn fibrous coverings with chromicized catgut.	Most satisfactory results.
45. Wright, J. Sherman. Intern. Clinics, 1905, vol. III, p. 155. Fractures of the Patella.	Male, 25 yrs.	Same day.	Fell while running in the street. Transverse fracture of the patella near its middle.	The prepatellar fibrous tissue sutured.	Fair result.
46. Wright, J. Sherman. Intern. Clinics, 1905, vol. III, p. 155.	Male, 65 yrs.		Slipped and fell on pavement against curbstone. About one-half inch of apex of patella broken off.	Fibrous tissue sutured.	Fair result.
47. Durand. Lyon Méd. 1906, vol. 106, p. 1126. Fracture de la rotule gauche; suture des ailerons	Male, 45 yrs.		Left patella fractured the first time by a fall in 1899. Refractured by running into an obstacle and falling backward. A large hæmarthrosis. Separation of 6 cm.	First fracture treated by immobilization; bad functional result. Second fracture treated by operation. Arthrotomy. Cleared out the debris of fibrous masses, blood clots and neo-membranes. The fractured surfaces of the fragments were freshened. The ailerons and prepatellar tissues were sutured. Wound closed.	Cure. Can walk almost in a perfect manner.
48. M. Patel. Revue de Chir., Paris, 1907, vol. 35, p. 536. Demonstration.	Female, 60 yrs.		Fracture of patella.	Suture des ailerons.	Excellent result.
49. Vallas. Revue de Chir. de Paris, 1907, vol. 35, p. 150. Demonstration.	Male.		Fracture of patella.	Suture of the ailerons.	14 days after the operation, patient walked out.
49a. Ruotte. Lyon Médical, 1906, vol. 107, p. 315.	Male.	5 days.	Made an effort to restrain a fall. Transverse fracture. Diastasis three fingers' breadth. Absolute impotency.	Semilunar, incision convexity downward. Swabbing of articulation, suture of ailerons and of prætellar tissues with catgut. Skin sutured with silkworm gut.	Six weeks after operation, patient left hospital. Flexion to right angle.
50. Battle, W. H. Lancet, 1898, vol. 2, p. 690. A case of compound fracture of the patella, due to a kick from a horse.	Male, 53 yrs.	5 hours.	Kicked on both knees by a horse. Two large fragments and several smaller ones. Two or three of the latter were removed.	The two larger fragments were joined together by silver wire, the ends of which were twisted and then hammered on to one of the fragments. A dressing of double cyanide gauze and absorbent wool applied and limb enclosed in a plaster of Paris cast. The latter was exchanged for a posterior splint on the 13th day. Aponeurosis sutured with silk and skin wound closed by interrupted sutures. A drainage tube was inserted.	Firm union of the patella. Discharged on the 34th day. Gait normal.

51. Doebbelin. Zur Behandlung der frischers Knie-scheibenbrüche. Centralb, für Chir., 1899, vol. 26, p. 215. Deutsche Medicinische Wochenschrift, 1899, Dec. 7th. 9 cases treated by open incision.	8 Males. 1 Female.			Horseshoe incision from one condyle to another. No digital exploration. Dry sponging of clots. No irrigation. Union of fragments by 2 catgut sutures and one of silk. Slanting perforation of fragments. Removed interposed tissue. Drainage through middle of wound. Leg in extension. Splint. Applied for 14 days.	Average time before attempting to walk 6 weeks. In one case only partial osseous union. In all other cases, osseous union. Verified by X-rays. In one of the cases the union at first was fibrous. At the end of one year it had become osseous. Mobility in all cases perfect.
52. Bidwell. Lancet, 1898, vol. 1, p. 791.			Some years ago fractured right patella. Recently fractured left patella. This was wired, but a few months afterwards was refractured. Wires broke.	It has been wired again.	
53. Wissemans. Bull et Mem. de la Soc. de Chir. de Paris, 1898, vol. 24, p. 865. Fracture comminutive de la rotule.			Kicked by a horse. Compound comminuted fracture of the patella.	Horseshoe shaped incision made. Arthrotomy suture of superior and inferior fragments. Ablation of large intermediate fragments to which were attached a few shreds of tissue. Owing to the perforation splintering fragments, some suture passed through quadriceps tendon and ligamentum patellæ. A large silver wire used to unite the two fragments on internal side.	Good results. Patient began to walk on 40th day.
54. Barker, A. E. Lancet, 1898, vol. 11, p. 467. The treatment of fractured bones by operation.			10 cases of old fractures. One was a comminuted fracture in which several loose fragments had to be removed. Many fragments in comminuted case. In 9 cases the fracture was treated by osseous suture.	Curved incision, convexity upward. Treated by osseous suture. One silver wire being used. The case of comminuted fracture was treated by circumferential looping of the fragments. In one case, the wire caused trouble in later years and had to be removed.	In 8 cases functional results admirable. 8 healed by first intention. In one there was inflammation of the periarticular structures.
55*a*. Meigs, J. V. Boston Med. & Sur. Jr., 1898, vol. 38, p. 33. Three cases of transverse fracture of the patella treated by wiring. Case 1.	Male, 23 yrs.	7 days.	Fell striking knee. Joint very much swollen and very painful. Articulation full of clotted blood. Patella fractured transversely in two fragments.	Silver wire 1-16 in. in diameter used to bind the fragments together. Capsular ligament of knee was carefully united over the patella by continuous suture. Posterior splint.	Could bend the knee with ease and perfectly and could walk without a limp. Discharged in six weeks.
55*b*. Meigs, J. V. Boston, N. & S. Jr., 1898, vol. 138, p. 33. Case III.	Male, 31 yrs.	14 days.	Suffered a fall, striking knee against curb. Knee greatly swollen and exceedingly painful. Transverse fracture. Joint filled with blood clots.	Transverse incision. Wired.	Left hospital 6 weeks after operation without deformity, without lameness and in excellent condition.
55*c*. Meigs, J. V. Boston M. & S. Jr., 1898, vol. 138, p. 33. Three cases of transverse fracture of the patella treated by wiring. Case II.	Male, 19 yrs.	3 days first time. 1 day second time.	Fell, striking right knee and capsule. Second time jumped from a wagon and fell to the ground. Transverse fracture. The wires were broken closely to the knots. Whole knee joint filled with clotted blood.	Vertical incision. Wired fragments with silver wire 1-16 of an inch in diameter. Capsular ligament of knee was carefully united over the patella by continuous catgut suture. Posterior splint.	Perfect union. Limb almost as useful as it was before the first fracture.
56. Sir Wm. Stokes. Brit. Med. Jr., 1898, vol. 11, p. 1668. Treatment of fracture of the patella by the open method.	Male, 28 yrs.	2d day.	Slipped and fell at the same time. Felt a crack. Fracture of right patella. Fragments separated 1 inch.	Vertical incision. Fibro-periosteal curtain over the fractured surface of fragments. Fragments sutured by sterilized silk (2 sutures). A month later left hospital.	Perfect knee. 5 months after knee was examined and found to be perfect.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
57. Warbasse, J. B. Annals of Sur., vol. 27, 1898, p. 601. 34 cases. The treatment of fractures of the lower extremity.		1 – 2 days. 1 – 1 day. 1 – 3 days. 2 – 5 days. 3 – 7 days. 6 – 10 days. 6 – 14 days. 1 – 15 days.	29 simple recent fractures. One compound. Six admitted for operation on account of soft union. Two were bilateral. With two exceptions, the line of fracture was transverse and near the middle of the bone. Two cases were refracture of wired patella. In one, the fracture was in the old line of union. The wires had broken at place of twisting. In the other, the fracture was at a new site. The old line of union was perfectly solid. One wire was found broken and the other had torn out of the bone.	In 29 cases of recent fracture, the joint was opened by an incision over the patella. Blood and exudates removed. Torn periosteum which had fallen between the torn fragments trimmed away. Bone fragments were sutured together. Wound closed. Limb placed in posterior splint. In 12 cases silver wire was used. In one case kangaroo tendon. In five cases, silkworm gut. In one case it was found that suturing the soft tissues was sufficient.	In 27 cases in which the open method was used, there was no septic joint disturbance. Permanent healing in all cases. Seven cases not treated by the open method. In six cases operated for fibrous union, operation was followed by solid bony union. Drainage used in ¾ of all cases. Drainage removed the 2d day or soon after. In two cases of refracture, recovery with good results.
59. Scudder, Dr. G. S. Boston Med. & Sur. Jr., 1898, vol. 138, p. 231. Comminuted fracture of each patella.	Male, 44 yrs.		Fell to sidewalk from a second story window. Comminuted fracture of each patella. That of the right patella was a compound fracture.	Excision of left patella and wiring of the right patella. Fragments small, numerous and widely separated. Little fluid in joint. Left knee, a 4 inch transverse incision below the patella opened joint. The patellar tendon and the quadriceps tendon and fascia were sutured with six catgut sutures. A small wick of gauze was left in each side of the joint. Right knee, compound fracture. Wound enlarged each way to the sides of the joint. Three fragments were sutured with silk sutures. The smaller fragments were removed. Both knees were immobilized upon posterior splints with wooden side splints and straps. These were removed and plaster of Paris splints applied to each leg. These were removed 4 weeks later; 7 weeks after operation passive motion; 9 weeks after operation patient walked on crutches.	Firm union of fragments of right knee. No disability. As strong as ever. Left knee, outside of slight limitation of motion, is functionally as strong as if there were present a normal and natural patella.
60. Phelps, Chas. N. Y. Med. Jr., 1898, vol. 68, p. 871. The results of open operation in the treatment of recent fractures of patella. 118 cases. 4 refractures: 3 months, 4 months, 6 months, 3 years after primary fracture. At secondary operation of these refractures, it was seen that ossific union had taken place at primary site of fracture.	One patient was 83 yrs. old.			A free lateral incision. Wired patella after having removed all tissues interposed between fragments. Passes silver wire through flame. Drains joint for 24 hours. Removes all retentive apparatus after the 28th day. Lateral movement of patella begun at 3d week to avoid adhesions of bone to the femoral condyles.	Apparent osseous union in 118. Ankylosis in 5.
61. Trinkler, N. P. Annalen der Russichen Chirurgie, 1899, Heft. 6.	Case 1. Male, 28 yrs. Case 2. Female, 32 yrs. Case 3. Female, 30 yrs.	1 month. 20 days. 1 month.	2 cm. diastasis. 3 fragments. 2 cm. diastasis. 4 cm. diastasis.	Bone sutured with 3 silk sutures. Same operation as above. Same operation as above.	Osseous union. Three years after, perfect function of joint. End of 7½ weeks walks freely on crutches. Bends knee to a right angle. 1 month after operation walks with cane. 4 months after operation bone shows firm union.
62. Pritchard, A. W. Brit. Med. Jour., 1899, vol. 1, p. 876. Demonstration.	Case *a*. Case *b*. Case *c*.	 Old fracture.	Simultaneous bilateral fracture. Successive bilateral fracture at an interval of a year. Had been treated unsuccessfully by other methods.	Osseous suture with silver wire.	Good results. Good results. Good results.

63*a*. Means, W. J. Columbus Med. Jour., 1899, vol. 23, p. 1. Case 1.	Male, 28 yrs.	Same day.	Fell on left knee. Compound comminuted fracture of the left knee.	Tissue trimmed. Constant irrigation with hot salt solution. Fragments of bone approximated with kangaroo tendons. Soft tissues by catgut. Posterior perforated zinc splint. Joint immobilized four weeks.	Good result.
63*b*. Case 2. Treatment of fractures of Patella.	Male, 32 yrs.		Fell first time and broke left patella. Non-operative treatment. Refractured second time when lifting a heavy load. Separation 1½ inches. The fibrous band uniting the fragments had separated in the middle.	Transverse incision. Fibrous tissue removed. Bone exposed and fragments united with three kangaroo tendons. Edges of lacerated aponeurosis united with catgut. Joint irrigated with normal salt solution. No drainage.	Used limb at end of six weeks. In four months knee normal.
63*c*. Case 3.	Male, 18 yrs.		Fell on knee. Integument contused but no lacerations. Comminuted fracture of patella.	Longitudinal incision. Fragments approximated by catgut.	Bony union. Complete restoration of joint in three months.
63*d*. Case 4.	Male, 25 yrs.		Fell from a tree and knee flexed under him. Left patella broken transversely.	Longitudinal incision. Same procedure as in previous case.	A perfect result obtained.
64. Monnier. Gazette des hôpitaux de Paris, 1899, vol. 72, p. 804. Pour servir a l'histoire des fractures de la rotule chez l'enfant et notamment de leur traitement par la suture métallique.	Male, 15 yrs.	8 days later.	Fell unable to get up. Three fragments.	Curviliner incision. Concavity above. The middle of incision reaches the anterior tibial tubercle. The ends 3 cm. above the interarticular line. Freshening of fractured surfaces. Tear of ailerons for 1 inch on either side of capsule. Wired patella. Sutured torn portions of capsule. Drainage. Passive motion 10 days after. 19 days after patient begins to walk with crutches.	Perfect anatomical and physiological results.
65*a*. Lotheisen. Beiträge, füer Kim. Chir., 1899, vol. 24 p. 673. Ueber die Zerreissungen im Streck apparat des Kniegelenks.	Male, 50 yrs.	2 mos.	Fall. Fractured right patella. Diastasis, fingers breadth.	Textor's resection, schnitt. Freshens the fragments. Uses two silver wires Sutures the ligamentum patellæ with catgut. Plaster of l aris cast.	Discharged 48 days after, O. K.
65*b*.	Male, 27 yrs.	6 months.	Slipped and fell against stone. Fracture of left patella. Old fracture with fibrous union of 4 mos. standing. This is a refracture. Diastasis: a finger's breadth.	Transverse incision. Removal of fibrous tissues. Silver wire in center. Peripatellar fascia sutured with silk laterally. No drainage. Plaster cast. On 11th day, removal of stitches.	50 days later flexion of 70 degrees. Extension complete.
65*c*.	Male, 52 yrs.	5 days.	Old fracture. Right patella. 2 inches separation.	Transverse incision. Two silver wires used.	54 days later, O. K.
65*d*.	Male, 19 yrs.	15 days.	Fall. Fracture of left patella. 15 days old. Much swelling. Upper fragment displaced upwards 4 cm. and also longitudinally fractured.	Cold applied. Transverse incision. Transverse fracture approximated by two silver wires. Peripatellar tissues sutured with catgut. No drainage. Stitches removed on the 20th day. Massage.	O. K. in 60 days.
65*e*.	Male, 73 yrs.	16 days.	Muscular action. Fracture of left patella. Swelling. Transverse fracture.	As fragments could not be kept together, operated 14 days later (after admission.) (Schleich's anesthesia.) Longitudinal incision. Two silver wires used. Drainage.	Osseous union. 60 days later verified by X-Rays.
65*f*.	Male, 20 yrs.	2 months.	Atrophy of quadriceps.	Transverse incision. Fractured fragments freshened. Two silver wires. Drainage. Plaster cast. 2 days elevation of leg. Stitches out on 8th day. 19th day Volkman splint. Silk sutures for soft tissues.	In 30 days O. K. Flexion of 100 degrees.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
66. Chandelux. Revue de Chir. de Paris, 1899, vol. 19, p. 574. Demonstration.	Male.	6th day.	Fracture. Interval between fragments 6 cm. Laceration of ailerons. Hemarthrosis.	Two osseous sutures. Irrigation of joint with 1-2000 bi-chloride sol. Soft tissues sutured with catgut. 55 days after, ablation of the metallic patellar sutures. One came out easily and the other broke and was abandoned.	On 70th day, coaptation perfect. Bony union. (Clinical verification.)
67. Dr. Powers, C. A. J. Am. Med. Assn., 1899, vol. 32, p. 239. Demonstration.	Male, 17 yrs.	4 days.	Refracture. Slipped and fell. ½ inch separation between fragments. Atrophy of the thigh. Joint full of blood clots. 3 inches greater in circumference than its fellow.	Only ¾ of the bony surface could be brought together by tight stretching. Fractured surfaces freshened. Fragments wired. Systematic massage of thigh and leg.	Flexion can be made to a right angle. Extension is strong and complete.
67a. Bissell, Jos. B. N. Y. Med, Jour., 1900, vol. 71, p. 195.	Male, 48 years.	5 months.	Fall while walking across floor. Treated for five months at another hospital by apparatus, adhesive straps, etc. Transverse fracture of patella, 2 inches separation.	Long transverse incision over middle of joint, wire inserted back from edges. Joint surface so filled with fibrous tissue as to completely change the joint itself. Rubber-tube draining of joint for first 24 hours.	Healed by first intention with close coaptation and perfect bony union. After second operation, healed with close coaptation and perfect bone union.
68a. Lauper. Correspondenzblatt für Schweizer Ärzte. Über Refracturæ Patellæ, vol. 34, p. 321, 1904.	37 yrs.		Made an effort to restrain fall and fell on back and fractured right patella. Intra-articular hemorrhage. Diastasis 5 cm. Shortly after refractured.	1st operation. Sutured prepatellar and parapatellar tissues. Immobilization 3 weeks. 2nd operation. Sutured bony fragments.	Very good functional recovery.
68b.	Male, 40 yrs. Letter carrier.		In attempt to increase motion, under narcosis, separation of fragments resulted.	1st operation. Osseous suture, healing by first intention. Immobilization for 6 weeks.	Good result. Flexion to right angle.
69. Sumpter, W. D. Memphis Med. Monthly, 1900, vol. 20, p. 120.	Male.	2 hrs.	While making connection between two electric wires, received a shock which caused him to fall and strike his right patella on the steel rail of the track beneath him.	Longitudinal incision. Removal from articulation of large amounts of liquid and clotted blood. Elevation of fibro-periosteal curtains. Joint irrigation with Hg. CL. 1-8000. 2 fragments wired. No drainage. The capsular rent was such that deep skin sutures were used, instead of special ones to the capsule.	About three months later the silver sutures had to be removed as they caused irritation and pain. Mobility of knee satisfactory.
70. Patterson. Brit. Med. Jr., 1900, vol. 1, p. 252. On suture of Fractured patella by an Improved Method.	Male, 24 yrs.	4 days.	Fell. U-shaped flap, convexity downward. Joint filled with firm and partly dissolved blood clot. Lower fragment tilted so that the articular cartilage was the part presenting.	Arthrotomy. Joint irrigation. Bony surfaces covered dense fibrous exudation and blood clot. A fringe of torn periosteum was included in that covering. Bone, silver wired. Divided aponeurosis and periosteum closely sutured with fine silk over underlying wire. Posterior splint on 8th day. Sutures removed on 14th day. Passive motion begun.	A skiagram taken three weeks after the operation, showed such accurate approximation that the fracture line is hardly discernible.
71. Middleton, G. M. The Railway Surgical Journal, 1904–05, vol. 11, p. 181.	Male, 35 yrs.	3 days.	Fractured right patella in alighting from train. Non-operative treatment. Six months later, refracture. This time operative treatment.	Sutured patella with kangaroo tendon. Also sutured kangaroo and aponeurotic structures with this material.	Good result. In three months, resumed work as brakeman.
72. Trimble, W. B. Med. Rec., N. Y., 1900, vol. 58, p 497. Case 1. Treatment of fractured patella. Reports two other cases with good results.	Male, 43 yrs.	Two months and three days after injury.	Caused by a fall. Right patella fractured, transversely.	Antiphlogistic treatment for five days. Expectant treatment 6 weeks. No union. The operation. Osseous suture. Passive motion of patella from side to side about the end of the second week. At the end of third week, flexion of knee was begun. At end of six weeks, patient was allowed to use his leg. Drainage was used for four days.	At end of 2 months dismissed with one-half motion. Afterwards regained full use of limb.
73a. Wright, J. Sherman. Phil. Med. Jour., 1900, vol. 5, p. 64. Two cases of simultaneous fracture of the patella treated by wiring the fragments.	Male, 41 yrs.	One month.	Received the impact of two hand trucks in each knee while making a strong muscular effort. Transverse fracture of each knee pan.	Believes drainage advisable for two or three days. Applies posterior splint.	Recovery in four weeks. Perfect union.

73*b*.	Male, 40 yrs.	14 days after fracture.	Fell on getting off a street car and struck pavement with both knees. The right patella had been fractured 6 yrs. before and wired. Simultaneous fracture of both patellæ.	Both patellæ were wired with perfect result in four weeks.	Full use of joint.
74*a*. Cox, Edwin M. Med. Rec. 1901, vol. 59, p. 53. The choice of suture for the patella.	Boy, 15 yrs.	Same evening.	Fell five stories. Compound comminuted fracture of one patella and other injuries. Simple fracture of femur on same side. Fracture of tibia and femur on opposite side.	Transverse incision. Washed out joint with salt solution. Removed several of the shattered patellar fragments and sutured those remaining with moderately heavy catgut. At end of two weeks posterior splint of plaster of Paris was removed. Very moderate massage begun.	At end of 10 weeks patient walked out of the hospital. At end of 9 months function of the knee was normal in every particular.
74*b*. Cox, Edwin M. Med. Rec., 1901, vol. 59, p. 52.	Male, 38 yrs. Priest.	7 days.	Direct violence. Simple transverse fracture. The flap of the aponeurosis covering the front of the bone had fallen between the fragments. It was so firmly adherent to the fractured surface of the upper fragment that it had to be scraped off.	Transverse incision. Cleared joint of blood clots. Clearly divided fragments united by two formalin catgut sutures of moderate size. Very moderate lateral motion was begun in two weeks.	14 months after operation, joint was absolutely normal.
74*c*.	Female, 30 yrs.	4 days.	Indirect violence. Simple fracture of patella.	Sutured patella with catgut.	At the end of eight weeks, patient walked home. At end of 12 weeks, movements of joint were almost normal.
75. Erdmann, J. P. Ann. of Surg., 1901, vol. 33, p. 488. Demonstration.	Male.		Patient had fracture of patella treated by massage two months. Later as a result of a fall, refracture occurred. Fragments were wired this time, but a light grade of wire was used. Second refracture occurred. Patient did not want to submit to an operation this time. A few months later returned with ankylosed knee and 8 cm. separation between the fragments.	Longitudinal incision. The upper fragment was found strongly adherent to the condyles of the femur and quadriceps had contracted to such a degree that it was impossible to bring the two fragments in apposition. An inverted "V" shaped incision through the tendon of quadriceps extensor and attachments of vastus externus and vastus internus liberated. Bone fragments were wired. Limb hyper-extended and immobilized by plaster of Paris. Splint.	Discharged in four weeks. Two years after operation, motion normal, and firm bony union between the fragments.
76. Lebesque. Jour. De Chir. et Ann. de la Soc. Belge. de Chir., Brux., 1901, vol. 1, p. 368. Du traitement de la fracture de la rotule.	Male, 53 yrs.	14 days.	One year before, sustained transverse fracture of left patella. In a state of intoxication, refractured same patella. The refracture was at a higher level. Determined by X-ray.	Immobilized for five weeks. No operation. Arthrotomy. Two vertical silver wire sutures.	Perfect recovery. Perfect recovery. Two years after the operation, one of the wires became untied and could be felt beneath the skin. It was removed. Five months after this, for a similar reason it was necessary to ablate the second silver wire. Perfect recovery.
77. Barton, Jas. M. Jour. Am. Med. Assn., 1901, vol. 36, p. 242. Fracture of the Patella.	Male.	10 days.	Physician fell from a bicycle. Lower fragment very short with a horizontal split that separated it into an upper and a lower portion.	Wired patella.	Complete recovery. Full and perfect motion.
78. Sheild, A. Marmaduke. The Lancet, 1901, vol. 1, p. 702. Glycosuria due to morphia complicating a case of fracture of the patella.	Male, 55 yrs.		Slipped and fell. Diastasis ¾ in. Upper fragment larger than lower.	Vertical incision. Washed out blood. Wired patella, two vertical wire sutures. Limb immobilized by means of a back splint and two lateral splints.	Left hospital. No union whatever between the fragments, the bone being entirely held by the wires. Could walk quite well and flex knee nearly to right angle. Developed glycosuria during convalescence.
79. Riedel. Deutsche Med. Wochenschrift, 1906, vol. 32 p. 2028. Die Catgutnaht bei Fractura Patellæ.		8 fresh fractures. 3 old fractures. One 18 months old.	In one case the upper fragment of the fractured patella was adherent to the femur.	Two small longitudinal incisions on each side of the patella. In old fractures excised interfragmentary scar-tissue. In one case, the upper patellar fragment had to be chiselled off from femur.	Good results.
80. Dr. Meyers, Willy. Ann. Surg. 1901, vol. 33, p. 194. Demonstration. Case 1.	Male, 35 yrs.	6 days.	Jumping from a wagon.	Fragments united with two large sized silver wires.	Allowed to walk at end of 6th week with full use of limb. Is able to bend knee to an angle of 60 degrees. Complete bony union.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
Case 2.	Female, 23 yrs.	12 days.	Fell on flexed knee. Comminuted fracture of left patella. Small lower fragment splintered. A loose spicula of bone was found between the two loose fragments.	Bone wired. Author waits until the beginning of the second week before suturing the patella.	Full use of limb. Bony union. Able to bend knee to an angle of 110 degrees.
Case 3.	Male.			Wired.	Satisfactory result. Wiring restores the bone to perfection. This insures against refractures the best.
81. Thienger. Beiträge fur Klin. Chir. 1902, vol. 36, p. 601. Zur operativen Behandlung frischer subkutaner Patellar fracturen durch offenene Knochennaht. 6 cases.	Males: 57 yrs. 24 yrs. Refracture. 25 yrs. 23 yrs. 27 yrs.	Operates as soon as possible.	4 left patellæ. 2 right patellæ.	Esmarch used. Longitudinal incision. Loose pieces of bone removed. Joint irrigated with normal salt solution. Does not touch wound with fingers. Bone silver wired. Peripatellar tissues united with silk. No drainage. Splint. Removal of stitches on 8th day. 4th week walking exercises in splint. 6th week no more splint.	In all cases osseous union. Verified by X-rays. Flexion 96 degrees. In one case, wire had to be removed several months after operation.
82. Starr, N. G. Canada Lancet, 1902, vol. 36, p. 549. Demonstration.	Male.	3rd day.	Transverse fracture. Fragments seperated three fingers width.	Vertical incision. Joint cleared of clots. The periosteum and the lacerated fragments of the extensor tendon overlapped the raw surfaces of the bone. These were removed and some tags were snipped off with scissors. Patella sutured with two silver wires.	At the end of third week, patient left hospital, wearing posterior splint which he manages remarkably well. Has been more or less continuously at work since leaving hospital.
83. Elsberg, Dr. Chas. A. Med. Rec., N. Y., 1902, vol. 61, p. 716. Demonstration.	Male.	Some months after second fracture operation was performed.	Fractured patella two years previously. With aid of knee-cap he was able to get along fairly well. About one year later, he refractured the patella. Large amount of fibrous tisssue was found between the ununited fragments.	Fibrous tissue was removed. Fragments sutured with chromicized catgut.	In six weeks, patient was walking. Almost perfect function.
84. Von Mikulicz. Brit. Med. Jr., 1902, vol. 11, p. 1828. A contribution to the treatment of fractured patella.			29 patients. 1 refracture.	Makes transverse incision long enough to expose the patella, torn peripatellar ligaments and torn part of capsule. Uses brass wire. He says it is stronger. Immobilizes limb for ten days. He does not use drainage. Only asepsis is practiced.	26 cases healed by first intention. 4 healing delayed by infection. Lack of proper asepsis. He traced 17 cases. In 12 results were good. In 4 moderately good. One unsatisfactory.
85. Courtney. St. Paul Med. Jr., vol. 4, p. 683, 1902. Fractures of the patella with special reference to their treatment by suture. Case 1.	Male, Waiter.		Indirect violence. Transverse fracture of right patella.	Arthrotomy. Detached fragments ½ inch long by ½ inch wide, thickness of the patella removed. Remaining portions of fragments sutured with chromicized catgut.	Complete bony union within two months. Complete restoration of function.
Case 2.	Male.		Transverse fracture of right patella.	Open operation. Bony fragments sutured with one silver wire and two chromicized catgut.	Bony union in six weeks. Complete restoration of function.
Case 3.	Male.		Indirect violence. Transverse fracture of right patella.	Arthrotomy. Bony fragments joined by one silver wire suture and fibro periosteal covering united with five interrupted catgut sutures of chromicized catgut.	Bony union in six weeks. Good results.
86a. Doberauer. Beiträge zur Klin. Chir., 1905, vol. 46. Fresh or recent fractures.	1897. Male, 41 yrs. 1897. Male, 34 yrs.	A few days. A few days.	Transverse fracture. Diastasis 2 cm. Transverse fracture. Diastasis 4 cm.	Began motion in three weeks. Began motion in five weeks.	Walked well. Flexion exceeds 90 degrees. Died 1904. autopsy shows osseous union. Good gait, active extension. Flexion 35 degrees. Free flexion and extension. Osseous union.

86*a*.—Continued.	1899. Male, 49 yrs.	A few days.	Transverse fracture. Diastasis 4 cm.	Began motion in three weeks.	Good motion and function. 1904 died. Autopsy shows osseous union.
	1900. Male, 51 yrs.	A few days.	Transverse fracture. Diastasis 2 cm.	Began motion in three weeks.	About ½ normal motion. Osseous union. Extension good. Flexion over 90 degrees. Locomotion good.
	1901. Male, 25 yrs.	A few days.	Transverse fracture. Diastasis 2 cm.	Began motion in four days.	Good function. Osseous union. Full extension. Almost full flexion.
	1900. Female, 40 yrs.	A few days.	Transverse fracture. Diastasis 3 cm.	Began motion in three weeks.	Left in 5 weeks, with fibrous union. Osseous union later. Atrophy of thigh, 1½ cm. Flexion 90 degrees.
	1903. Male, 18 yrs.	A few days.	Transverse fracture. Diastasis 4 cm.	Began motion in 18 days.	Good function. Osseous union. Absolutely normal function.
	1895. Male, 42 yrs.	9 days.	Transverse fracture.	Began motion 16 days after operation.	Osseous union. Extension free. Flexion as on opposite side.
86*b*. Doberauer. Beiträge. zur Klin. Chir., 1905, vol. 46. Old fractures.	*a*. 1898. Male, 46 yrs.		Compound transverse fracture.		Died. Bad general condition.
	b. 1899. Male, 18 yrs.		Transverse fracture 12 weeks old. Diastasis 2 cm.	Began motion at end of 3d week.	Osseous callus. Function normal. Slight pain ascending stairs.
	c. 1900. Male, 18 yrs.		Transverse fracture. 8 weeks old. Diastasis 2 cm.	Began motion in four weeks.	Firm union. Flexion 45 degrees. Extension normal. Refractured after returning home. Diastasis, but no marked diminution of function.
	d. 1901. Male, 29 yrs.		Transverse fracture 5 months old, Diastasis 4 cm.	Began motion in 16 days.	Osseous union. Full normal function.
	e. 1903. Male, 43 yrs.		Transverse fracture 3½ months old. Diastasis 2 cm.	Began motion in 3 weeks.	Osseous union. Extension free. Flexion 90 degrees.
87. Lucas Championnière. Archives Internationales de Chir., Gand., 1903, vol. 1, p. 27. 70 cases. La suture de la rotule Étude pratique sur le traitement dela fracture de la rotule par la suture.	11 Females, 59 Males. 29 over 40 yrs. 9 over 50 yrs. 1 65 yrs.		In a large number of cases a large flap of fibrous tissue coming from the anterior surface of the patella is interposed between the fragments.	Wants a large opening. Always sutures the bone. Believes in metallic sutures. Uses silver wire. Always sutures the fibrous tissue in front of the patella. Articulation must be voided of all morbid products. He believes in antisepsis not asepsis. On 18th day, encourages walking. Irrigation of joint.	Only one case of suppuration. Knee remained stiff. In all other cases, results were excellent.
88. Charters, Symonds. Brit. Med. Jr., 1903, vol. 1, p. 1026. Demonstration.	Male.		Lower third of leg removed on account of crushed foot. Walking on crutches. Two months later, he fell. Admitted in to Guy's Hospital. Simple transverse fracture of the patella.	Arthrotomy. Bone silver-wired sutured. The joint was massaged in a few days.	In two weeks, could flex the knee to a right angle. The range of movement is at present complete.
89. Stevens, Bertram C. Lancert, 1903, vol. 1, p. 1101. A case of fractured patella with hints on the post-operative treatment.	Male.	24 hrs.	Horse with his fore-foot stepped on patient's knee-cap. One inch separation.	4 inch incision. Osseous suture. Two silver wires vertically inserted. Soft tissues and tendinous aponeurosis were stitched over the wires and the wound closed Passive motion 8th day.	At the end of 5½ weeks, patient walked without crutches several miles to report to medical attendant.
90*a*. Fowler. Med. News, 1903, vol. 82, p. 592.	Male, 58 yrs.	12 days.	Right patella fractured 9 years ago. This time the left patella fractured. 2½ inches separation.	Internal curved incision. Edges of torn capsule interposed between the fragments. Fragments approximated by through and through sutures of kangaroo.	Bony union. Case discharged 63 days after operation. Almost normal movement.
90*b*. Fowler. Med. News 1903, vol. 82, p. 592. The operative treatment of fracture of the patella.	Male, 33 yrs.	15 days.	Fractured right patella which was treated by the non-operative method. 8 months later, refractured. Operated but bad functional result from adhesions. Again refractured right patella by muscular action. Transverse fracture ½ in. separation. Wide separation of fragments. Capsule absolutely fractured. Two broken sutures of silver wire from previous operation removed.	Holes drilled into fragments. Approximation secured by heavy catgut. Capsule sutured with chromicized catgut.	Discharged 73 days after operation, with some though not solid union.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
90*c*. Fowler. Med. News, 1903, vol. 82, p. 592.		14 days.	Blow from nozzle of hose. Both fragments tilted forward. 2½ inch separation.	Fragments drilled and two sutures of kangaroo introduced, capsule sutured with kangaroo tendon. Patient persistently refuses to follow instructions. Hence the results are imperfect	16 days after operation, passive motion begun.
91. Lane, Ernest. Med. Press and Circ., London, 1903, vol. 127, p. 452.	Male, 28 yrs.	3 days.	Considerable effusion in the joint. ¾ in. between the fragments. Capsule of joint deflected over both broken surfaces. The lower fragment was in a somewhat peculiar position, the apex of the patella pointing backwards and the cartilage covered posterior surface looking upwards.	Semi-lunar incision convexity downwards. Reflected flap upwards. Patella wired. One wire used. Irrigation of operative field.	Result not stated.
92. Bärlochen, H. Correspondenzblatt fur Schweizer Ärzte, 1903, vol. 32, p. 105. 28 cases.		2d day.	2 cases were compound fractures, 1 case longitudinal fracture, 7 cases comminuted fractures, balance transverse fractures. In every case it was seen at operation that the fractured surfaces were covered by interposing soft parts which would have prevented osseous union had subcutaneous suture or non-operative treatment been employed. In every case there was hemorrhage into the joint.	Longitudinal incision 6–8 cm. Osseous suture. Dry treatment of opened joint. Periosteal suture of patella. Silk suture of the capsule. Complete closure of wound. Immobilization 4 weeks. Early exercising of limb.	20 cases healed by first intention. Good result as to function. First case recovery was retarded by paralysis of ext. peroneal nerve. One case recovery was retarded by pleuritis. One case healed by ankylosis. One case died of delirium tremens. One case died of pneumonia
93. Routier. Bull. et Mém. de la Soc. de Chir. de Paris, 1909, vol. 28, p. 280. Fracture itérative de la rotule. Demonstration.	Male.	2 days.	Four months previously patient had fractured his right patella. Articulation was filled with clotted blood. Fibrous debris was interposed between the bony fragments. Second fracture. Both silver wires were ruptured.	Two silver wires were inserted. Patella sutured transversely. Fractured surfaces were overlapped by fibrous tissues.	Patient walked in 15 days. 14 days later was walking. Recovery.
94. Edw. Martin and T. T. Thomas. The Railway Surgical Age, 1904–05, vol. 11, p. 207. 11 cases.				Horseshoe incision beginning over the posterior surface of the lower extremity of one femoral condyle and carried across to a similar point on opposite side. Cleansing of joint with normal saline solution. If fracture be not comminuted, one silver wire will suffice. No drainage. In six weeks the splint can be removed.	Good result.
95*a*. Morison, Dr. A. E. Brit. Med. Jr., 1903, vol. 2, p. 1464.	Male.	30 hours.	Kicked by a horse. Compound comminuted fracture.	Wired. Knee joint washed out. Drainage tube inserted into the joint for 24 hours. Passive movement commenced ten days after.	Usefulness of limb perfect.
95*b*.		18 hours.	Indirect violence. Fracture of patella.		Complete use of limb.
95*c*.		24 hours.	Indirect violence. Fracture of patella.		Complete use of limb.
95*d*.	Female.	4 days after second accident.	Accident April, 1901. Treated by prolonged rest, etc., for 6 weeks. Fracture of the patella. About 2 inches of fibrous tissue separated the two fragments, and her leg was weak and gave way under her when going down stairs in April, 1902. Slipped on ice and ruptured the fibrous band.	Two ends of the patella were freshened and wired. The knee joint was full of blood clots and was washed out with 1-1000 bichloride solution. Passive movement was commenced on the 8th day.	Useful limb resulted.

96*a*. Hutchinson, J. Alex. Ann. of Surg., 1904, vol. 40, p. 571.	Male, 24 yrs.	56 days.	Direct violence. Transverse fracture. Stellate fracture of upper fragment. Large transverse rupture of aponeurosis. Mass of fibrous tissue between the fragments.	Median linear incision. Silver wire first used, but broke. Replaced by 5 strands of silk worm gut through one centrally drilled opening. Approximation of fragments impossible until a silk suture had been passed through the aponeurosis above and below the patella and tied. Plaster of Paris for 6 weeks.	Complete restoration of function.
96*b*.	Male, 29 yrs.	11 days.	Fell on knee. Low transverse fracture. Marked synovitis. Severe injury to superficial soft tissues.	Semi-lunar incision. Convexity upward. Large oblique rent of soft tissues extending from a point about 2 inches below fracture line on inner side to edge of fracture on outer side. Fringes of soft tissues 2 in. long hung over the fractured surfaces of upper fragment. Single silver wire. Plaster of Paris for six weeks. Superficial suppuration from original damage of soft tissue.	Bony union not complete. Movement of joint not normal.
96*c*.	Male, 50 yrs.	16 days.	Transverse fracture. Aponeurosis torn below line of fracture.	Semi-lunar incision. Convexity downward. Silver wire. Plaster of Paris for three weeks.	Bony union complete. Restoration of function.
96*d*.	Male, 41 yrs.	8 days.	Transverse fracture of patella. Synovitis. Comminution of lower fragment. Aponeurosis torn below line of fracture. Large blood clots in joint cavity.	Chromicized catgut suture through laterally drilled openings in upper fragment passed between comminuted lower fragments through patellar ligament Posterior splint and elevation of thigh for a few days. Light massage and passive motion.	Gradual return of function. Patella freely moveable and no pain.
96*e*.	Male, 22 yrs.	13 days.	Transverse fracture. Marked synovitis. Separation $\frac{3}{4}$ inch.	Semi-lunar incision. Convexity downward. Aponeurosis torn below line of fracture. Upper portion lying between fragments in numerous bands and threads. Large blood clots in cavity. Silver wire. Posterior splint.	Walked without assistance or support in two weeks.
96$\frac{1}{2}$. Davis, Dr. Thos. A. Ann. of Surg, 1904, vol. 39, p. 141.	Male.	10 days. 10 days.	Alighting from car in Chicago. Transverse fracture of patella. 6 months later, horse lurched against him. Came to Chicago. At same depot and under same conditions fractured other patella. Found function was not good although patient had control of leg. Found separation of 2 to 3 inches of the fragments of the first fracture and a separation of $\frac{3}{4}$ in. in the recent fracture.	Horseshoe shaped incision was made and the fragments united with silver wire after drilling through fragments. Same procedure as in the first case. Week later found a separation of 1 inch. Anesthetized him and found wires broken. 2 weeks later finding the rewiring of the recent fracture held, operated on the old one. Unable to get accurate approximation. Did tendo-plastic operation on the quadriceps extensor, brought edges into approximation. After freshening the bony fragments sutured them with silver wire Sutured soft tissues with catgut.	Returned to his home in Minneapolis There had been firm calcareous union of the old fracture even if it was not true bony union. Good result.
97. Madden, Dr. Wm. Brooklyn, M. Jr., 1904, vol. 18, p. 193. Simultaneous fracture of both patellæ. Demonstration.	Female, 28 yrs.	5 days.	Simultaneous fracture of both patellæ. Fell forward while descending some steps. Both knees struck the ground. Transverse fracture of both patellæ. Crepitus. Sulcus between the upper and lower fragments. Joint contained much blood and effused material. Fringe of capsule trimmed off.	A U-shaped incision. Convexity downward from over the outer condyle well down to the ligamentum patellæ up into the inner condyle. Considerable tearing of the aponeurosis had occurred. Fractured surfaces approximated by six No. 3 chromicized gut sutures. Torn aponeurotic and fibrous tissues sutured with fine chromicized gut. External incision closed with silk wormgut. Whole leg enclosed in plaster of Paris. Dressing removed at end of six weeks. Passive movements. Posterior splint worn also for a few weeks.	Good osseous union. Restoration of function.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operation Procedure	Results
98. Budinger. La Semaine Méd., 1904, vol. 24, p. 1812. 2 cases.			Atrophy of the vasti.	Sutured patella. Cleaned out joint. Sutured the prepatellar and the peripatellar soft tissues. At end of a week gives massage and passive motion followed by active movements.	Result good.
99. Halstead, A. E. J. A. M. A., 1904, vol. 42, p. 789. Demonstration.	Male.		Compound comminuted fracture of patella. Ext. condyle completely fractured off.	Patella sutured with catgut. Join washed out with 5 per cent aqueous sol. of carbolic acid. Cigarette drain.	Result excellent.
100. Schlange, Wm. Hannover Verhandlungen der Deutschen Gasellschaft für Chirurgie Vierunddreissigster Congress, 1905, vol. 34, p. 181; Berlin, 1905. 30 cases.				Longitudinal incision. Does not in fresh fractures freshen the fractured surfaces. Sutures bone with one or two metal wires. Repairs tears in capsule.	Excellent results.
100a. Same reference as 100. Riese. 16 cases.				Irrigate joint with normal salt solution. Bores bone with electric drill. Sews bone with catgut. Does not drain. Sutures reserve extensor apparatus.	Good osseous union. Good function.
101. Dumstrey. La Presse Méd., 1904, vol. 12, p. 197. Refection de la rotule.	Male.	1 hour.	Multiple contusion of knee. Compound fracture of the patella. Two almost equal fragments. Lower fragment divided into 6 parts. Some were floating in the articular cavity. Interfragmentary space between the two largest fragments 5-7 cm.	Detached ligamentum patellæ and a plate of underlying bone. This plate was turned upward and sutured to the upper fragment with silver wire.	Two months later left hospital with almost perfect knee. Silver wire caused disturbance, was removed in 3½ wks.
102. Schmidt, George. Beitr. z. klin. Chir., 1903, vol. 39, p. 711. Uber die Entstehung und Behandlung der Knieschreibenbrüche.	45 Male. 6 Female. Age: 0–10, 0; 11–20, 2; 21–30, 7; 31–40, 18; 41–50; 12; 51–60, 9; 61–70, 3; 4 refractures all inside 1 year. 1 case in which bone was twice refractured.		8 tear fractures, 2 blow fractures, 22 tear and blow fractures. Right patella.	Transverse incision. Coagula removed with sharp curette under constant rinsing with warm salt solution. Fragment surfaces refreshened. Suture of bones with several aluminum-bronze wires. Capsule with ⅔ wires. Periosteum with silk or catgut. The wound is left open on both ends for 1cm., no regular drainage. Silkworm gut for peripatellar tissue. Volkmann's T splint plaster. Functional attempts as early as possible.	17 cases osseous union. 7 cases fibrous union.
102a. Chavannaz gazette Heldetnadaire des sciences méticales de Bordeaux 1903 vol. 24, p. 212, 213.	Male, 43 years.			Longitudiual incision. Bone silver wired. Lacerations in soft tissues repaired with catgut. Hands do not come in contact with articular surfaces. Liquid and clotted blood mopped out of articular cavity by aid of gauze swabs. Massage began on 15th day.	Extension perfect, no limping. Flexion is not quite as free as on unaffected side. Uses bicycle with great ease. Patient carries heavy weight.
103. Dr. Lenger. Rev. Orthop. de Paris, 1904, 2nd ser., vol. 5, p. 188. 53 cases. Traitement des fractures recentes de la rotule par l'arthrotomie et la suture métallique des fragments.			Opens the articulation and removes all blood clots adherent to seat of fracture. Then irrigates the joint with 2½% carbolic acid solution. Uses silver wire 1½ mm. in diameter to suture the bone. Then sterilized silk is used to suture the prepatellar fibroid periosteal tissues. Skin is sutured with silkworm gut. Immobilizes the joints 20 days by aid of a posterior splint. At end of 6 weeks, patients are discharged. Bone perforated with Lucas Championnières poincon.		All cases recovered.

104. Kroner, M. Deutsche Med. Wochensch, 1905, vol. 31, p. 996. Ein Fall von Flächen-fractur und Luxation der Patella.	Female, 31 yrs. In this patient the patellæ were more towards the ext. condyle than normally.		Felt a sharp pain in knee and then fell. Active motion impossible. Passive motion very painful. Patella fractured in a frontal plane into 2 fragments. The fragment which included articular cartilaginous surface was luxated and had hooked itself with its lateral edge upon the ext. condyle. The other fragment included the anterior convex part of the bone. It was maintained by quadriceps extensor muscle approximately in its normal position.	Curvilinear incision on inner side of patella. Arthrotomy. Displaced fragment replaced. 3 catgut sutures through whole thickness of patella. Capsular tears repaired. Began passive motion on 12th day.	After 40 days function good. 3 months later normal function.
105. Oehlecker, F. Berlin Städtische Krankenhaus, (Dr. W. Korte,) Arch. Chir., 1905, vol. 77, p. 751. Resultate blutiger und unblutiger Behandlung von Patella fracturen. 70 cases. 24 non-operative, 11 subcutaneous, 25 open operative.	Age 30 to 50. 61 males. 9 females. 46 due to violence. 24 due to muscular action. Youngest patient, 19 yrs.old. Oldest patient, 76 yrs. old.	Operates from 2 to 5 days according to hemarthrosis.		Esmarch. At first, used horseshoe incision with base above; latter with base below. Does not touch articulation with bare hands. Does not irrigate articulation. Dry sponging of clots. Excision of interposed tissues. Bone silver wired. Sutures with iodized catgut pre- and peripatellar tissues. Drainage at inferior angle of wound. Splint. Stitches taken out in 8 days. 10 days later, starts massage and passive motion. In three weeks, patient is allowed to cautiously use joint.	23 of the 25 open operatively cases treated were seen later. They had all fully recovered the use of the articulation. Osseous union was present in all.
106. Mullin, C. M. Lancet, 1905, vol. 2, p. 879. 12 open operations.		Operates on patients, 3 or 4 days after injury.	Fracture of patella.	Removes all blood clots in joint. Raises the fringe over the fragments. Torn fascia and aponeurosis united with catgut. Wire does not project through the cartilaginous surfaces. No carbolic acid or other antiseptics are allowed to touch the interior of the joint. He begins massage as soon as the wound is healed. The first motion of patella should be lateral motion. No drainage.	By end of 4th week patient is allowed to walk. These 12 patients can walk perfectly well and kneel. He allows patients to get up in 3 weeks.
107. Jowers, R. F. Lancet, 1905, vol. 1, p. 363.			Fractured patella.	Wired.	Perfect bony union.
108*a*. Wright, J. Sherman. Internat. Clinics, 1905, vol. 3, 15th Ser., p. 155. Fracture of the Patella.	Female, 45 yrs.		Fell down flight of stone steps. Heard a crack in her right knee before hitting steps. Transverse fracture of right patella near middle. Complete rupture of the ligamentum patellæ.	The fragments were wired with good result.	
108*b*.	Male, 23 yrs.		Lost balance and fell backward while sparring. Transverse fracture of left patella.	Fragments wired.	Some limitation of motion.
108*c*	Male, 25 yrs.	Same day.	Muscular action.	Prepatellar fibrous tissues sutured.	Fair results.
108*d*.	Male, 22 yrs.		Fell into the hold of a canal boat. This is a refracture. Transverse fracture of right patella.	Fragments wired after refracture.	
108*e*.	Female, 40 yrs.		A very stout woman. Suddenly twisted knee and fell to the floor. Transverse fracture of right patella and rupture of the ligamentum patellæ over the apex of the lower fragments.	She was treated by osseous wiring and suture of ligament.	

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
109. Terry, C. H. Brooklyn Med. Jr., 1905, vol. 19, p. 38. Suture of old fracture of the patella.	Male, Young.	Two months.	Two years previously had fractured patella. Non-operative treatment. Two months previous to admission, refractured patella.	Flap with concavity upward. Broken fragments had become atrophied. In freshening the edges, the operator had to cut good deal of tissue away in order to get a solid portion of bone to suture. An attempt was made to draw the fragments together with silver wire, but the sutures broke and he made use of chromic gut. The leg was put in a plaster cast for six weeks.	Motion is more or less limited but the patient has a perfect patella.
110. Bockenheimer. Von Bergmann's Klin. Arch. f. Klin. Chir., 1905, vol. 78, p. 187. 55 cases. 45 cases operated 10 cases non-operative. Einige Bemerkungen über die blutige Behandlung der Querfractur der Patella.	53 Males, 2 Females. Average age, 20 – 50 yrs.	Operates about 8 days after injury.	47 due to direct violence. 8 due to muscular action. Line of fracture in 45 transverse, 7 oblique, 3 splintered. Two cases were old fractures.	Most perfect asepsis. Do not touch wound with fingers. No Esmarch. Longitudinal incision. Retractors used. Remove blood clots. No irrigation. Remove interposed tissue. Freshen edges of fragments. Drill holes in the fragments, slanting, electric motor used. 2 or 3 aluminum bronze wires. Peripatellar structures sutured with catgut. Iodoform tampon drainage. Skin sutured with silk. Cast from hip to foot. Slight flexion of limb. Removal of tampon and stitches about 8th day. In 14 days massage of quadriceps through fenestrated opening. In three weeks cast removed, keeping only posterior splint; in 4 or 5 weeks, active motion.	Osseous union in 40 operative cases, fibrous union in 3. Refracture of one in 10 years after operation. One six weeks after. Durable result in operative cases in percentage of utility. 25, 90–100%; 5 (2 fibrous), 75%; 15, (3 fibrous), 50%. One death from pulmonary embolism.
110a. Deutsche Zeitschrift für Chir. Lichtenauer, Bd. 53, p. 165.	Male, 35 yrs.	Next day.	Fell down several steps. Was able to stand up, but unable to walk forward. He could make a few steps backward. Transverse fracture. Effusion. Interval of 2 fingers' breadth between fragments. Complete loss of extension.	Open operation. Cleaned joint with tampons. Sewed soft tissues with silk. Drainage.	Osseous union. Restoration of function.
111. Bogart, A. H. Compound fracture of the Patella. Brooklyn Med. Jr., vol. 19, 1905, p. 127. Case 1.	Female, 14 yrs.		Compound fracture. 3 in. wound over patella.	Bone wired. Open operation. Irrigation of joint with normal salt solution. Capsule sutured with catgut. Drainage.	Recovery. One month after operation, joint admitted of slight flexion and extension.
Case 2.	Male 26 yrs.		Kicked by horse over left knee. Immediately after accident, patient was able to walk ¼ of a mile. Patella fractured in three fragments.	Open operation. Bone wired. Capsule sutured with catgut.	Recovery.
112. Fells & Bentall, Brit. Med. Jr., 1905, vol. 1. p. 75.	Male, 42 yrs.	1 day.	Patient was pressed to the ground with a heavy sack on his back. Author states there seems to have been a two-fold fracture in this case. First by muscular action. Patella was fractured in two fragments. Then by violent fall on ground lower fragment was smashed. Swelling was so excessive that he only discovered the fracture later on. Patella broken in two pieces. The lower ⅓ of the patella was smashed into five fragments. Separation of 1 inch.	Horseshoe shaped incision, convexity upward. Capsule of joint transversely ruptured on either side. An attempt was made to bind the fragments together with silk. Wire would only crush them still smaller. A wire was passed through the larger upper fragment and under the lower fragment and tightened. The apposition was not accurate. The apposition was considerably improved by suturing the fibro-periosteal tissues and the rent in the capsule. No drainage. McIntyre splint.	Six months after the operation, patient was able to flex the limb more than 60 degrees. He could walk 6 or 7 miles without discomfort, but longer distances still caused some pain.
113. Trendelenburg. Ther. der Gegenwart, 1905, vol. 46, p. 17. Erfolge der Knochennaht bei Kniescheibenbrüchen. Operated first case in 1878.	75 cases. 1, 62 yrs. old. 1, 71 yrs. old.	Operates 6 to 7 days after injury.		Crescent shaped incision, convexity upward. Begins movements 8–10 days after injury. He first used silver wire. Now he uses iron wire. Sutures bone and also sutures the capsule of the joint. No drainage.	In two patients, there was a refracture. One case of ankylosis. Results otherwise very good.

113*a*. McWilliams, Clarence Medical Record, 1905, vol. 68, p. 969.				Transverse incision. Joint thoroughly irrigated with salt salution. Fragments approximated and sewed together by interrupted sutures of catgut. Torn fibrous expansions of the capsule on the sides of patella are also sutured. Drainage of subcutaneous tissues. At end of 16 days plaster splint removed daily for purpose of massage.	At end of sixth week, left hospital with serviceable knee.
114. Goellner, Strassburger. Med. Zeitung, 1905, No. 7. 6 cases.		Operates 8 days after injury.		All his old fractures non-operatively treated showed considerable disturbance in function and anatomical defect.	Results. 5 osseous unions. Results excellent.
115. Sträter, Zentralblatt für Chir., Leipzig, 1903, vol. 30, p. 149. Zur operativen Behandung der veralteten Patellarfractur.	Female.		Bilateral fracture. One was two days old. The other was two years old. It had been treated by massage. In full extension there was a separation of fragments of 6½ cm. In flexion to 90 degrees, diastasis was 10 cm. Absolute extensor paralysis.	Fresh fracture easily repaired. Old fracture necessitated a Z-shaped lengthening of quadriceps extensor tendon. Displaced upward the anterior tibial tubercle. Sutured and looped patella with silver wire. Suture of soft parts. Drainage of soft parts with CHI 3 gauze. Immobilization.	2½ months later patient could walk easily and painlessly. Function normal in both knees.
116. Lucas-Championnière, Bull. et Mém. de la Société de Chirurgie, Paris, 1904, vol. 30, p. 208. Demonstration.	Male, 43 yrs.		Left patella fractured by fall from scaffold. Contusion of skin.	Incision flap with convexity downwards. Two wires were passed vertically and one wire was passed diagonally, bringing the five fragments into apposition	Perfect union. Mobilized 14 days after operation.
117. Smith, Herbert. Cand. Jour. Med. and Surg., Toronto, 1904, vol. 15, p. 336. A case of fracture of the Patella treated by the open method.	Male.		Patella fractured transversely. The upper fragment and the inner segment of this split like a biscuit.	Incision, horseshoe with convexity downwards. Joint was distended with clots. Bone wired. Joint irrigated with hot water.	Patient went home. Thirty days after operation joint perfect.
117*a*. Rigby, Hugh M. The Practitioner, 1905, vol. 74, p. 604. The operative treatment of fracture of the patella. 21 cases.	Two of his cases were refractures.	Exposes the fragments by a vertical transverse or semilinear incision. He prefers semilinear incision; empties the joint of blood clot, serum and torn tissue with sterilized gauze; freshens the surfaces of the fragments; passes the wires through holes bored by a drill; uses two wires if possible; sutures the lateral tears in the expansion of the quadriceps; in comminuted fractures loops patella with silk or kangeroo tendon; uses preferably an electric drill to bore holes in bones; uses silver wire for bone suture; catgut used to repair tears in the lateral expansions; drainage for 48 hours. Begins massage usually after 12 days. In one case suppuration of knee followed by disorganization and ultimately amputation of the leg; one case ankylosis. Other cases resulted in good recoveries.			
118. Kausch, W. Zentralblatt f. Chirurgie, vol. 34, 1907, p. 530. Zur Frage und Technik der Patellar naht.	Male, 66 yrs.	3 days.	Knocked knee against edge of stone steps. Could neither extend leg, nor walk, nor stand.	X-rays showed fracture at junction of lower and middle thirds of bone. Five fragments and several splinters.	Irrigation of joint. Sutures bone with thick aluminum bronze wire. Suture of lateral ligaments. Early massage. Osseous union.
119. Gibbon, J. H. New York Med. Jr., 1905, vol. 82, p. 1089. 7 operations. Two patients over 60 years of age. Open treatment of Fractures of the Patella.		An early operation is advocated.		Transverse curvilinear operation allowing easy access to the torn ligaments. An absorbable suture, preferably chromicized catgut should be employed. In many instances I have had to use the periosteal elevator or some other similar instrument for the purpose of separating the fibrous tissue from the fractured surfaces.	Anatomical and functional results perfect.
120. Cathcart, Chas. W. Lancet, 1905, vol. 2, p. 1839. Case of Refracture. Demonstration.			Account of muscular violence. Joint filled with blood clots. Interval between the fragments was filled with blood clots and fibrous tissue. Six months after first fracture, refractured while lifting heavy weight. Refracture of patella.	Edges of bones brought together by means of five chromicized catgut stitches. Silver wire employed.	Good result. Complete bony union. Good result.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
121. Thiem. Werhandlung der Deutschen Gesellschaft für Chirurgie, 1905, vol. 34, p. 374. 12 cases. Riese, same reference as above but p. 192, 16 cases.				Bone suture. Uses catgut. In fresh cases sutures præ and parapatellar tissues. Bone suture. Irrigates joint with Na Cl. solution. Sutures parapatellar ligaments. Sutures bone with catgut.	11 osseous union and 1 fibrous union of such proximity that only the X-ray showed it to be fibrous. Osseous union. Good functional result.
122. Van Lennep. Hahneman Monthly, 1905, vol. 40, p. 667. The treatment of fractures of the patella.	Male, 24 yrs.	5 weeks after operation.	Transverse fracture. Diastasis 1½ in.	Arthrotomy. Fractured surfaces cov. fibro-periosteal fringe. Lateral fascial tears sutured.	Result entirely satisfactory.
123*a*. Scannell, D. D Bost. M. & S. Jr., 1906, vol. 155, p. 568. Compound fractures of the patella.	Boy, 10 yrs.		Struck by a locomotive. Vertical compound fracture of patella. Laceration of wound of the right patella, connecting directly with the fracture of the patella. No separation of fragments.	All fringes between the fragments cut away. Fragments of bones sutured with catgut. Likewise the capsule. Drainage. Secondary operation, two days later, for evacuation of pus. One month later another exploration of joint.	Ankylosis. Only 10 degrees of flexion.
123*b*.	Male, 39 yrs.	At once.	Fell, striking left knee. Compound comminuted fracture of patella. Edges of the original wound were excised to make fresh surfaces.	Elliptical flap, convexity downward. Joint washed out with salt sol. Several small pieces of bone removed. Approximation of fragments with kangaroo tendon. Capsule sutured with catgut. No drainage. Massage. One month after operation, passive motion.	Complete extension and about 50 degrees of flexion. Able to get about with no difficulty.
124. Clarke, Jackson. Med. Press & Cir., London, 1906, vol. 133, p. 471.	Female, 45 yrs.	Six months. Usually operates 5 days after accident.	Tripped over slight obstacle and fractured right patella. Five or 6 years previously had fractured left patella. Both patellæ were fractured, but not at the same time. In old fracture, diastasis 2 in.	Wired. Fragments perforated at two points. "U" shaped flap. Gives more complete access than lateral incision. Drained 24 hours. Begins slight passive motion 15 days after operation.	Good result.
125. Deanesley. Brit. M. J., 1906, vol. 1, p. 1341. Several cases. Demonstration.			Ordinary cases of transverse fractures.	Two sutures were used passing through whole breadth of fragments and consisting each of four sutures of stout silkworm gut threads. Aponeurosis sutured with silkworm gut. Back splint applied 24 hours only. Patient encouraged to active movements of knee from the first. One of his patients walked with aid of cane 9 days after operation. An ounce of voluntary exercise is worth a ton of massage.	Good results.
125*a*. Senn. E. J. Surgery, Gyn. and Obst., 1906, vol. 3, p. 821.	Male, 36.	5 days.	Patient thinks he struck on right knee and then fell forward; several fragments were present.	Vertical incision in middle line. Lacerated tissue between fragments removed. Sutured torn soft tissues with iodized catgut. Transverse rents in capsule, united also by catgut stitches. Immobilization 5 weeks.	Good result. A month after discharge, power of flexion almost normal.
125*b*. L. L. McArthur, same reference as 125*b*.			Simultaneous fracture of both patellas. One patella had been fractured some years before and treated non-operatively. It had healed with fibrous union. This fibrous tissue had become elongated.	For the refractured patella, operator incised lower berry fragment, sutured old fibrous band of union to ligamentum patella. In other patella, fragments silver-wired.	In knee with partial patella, useful joint. In other patella, bony union. Patient can walk without crutch or cane.
126. Ranzi. Arch. of Klin. Chir., 1906, vol. 80, p. 569. 21 cases.	Ages, 23 to 67. 19 Males. 2 Females. 14 Right patellæ. 6 Left patellæ. 14 due to a blow or fall. 7 due purely to muscular action.		Diastasis varied from 1 to 3 cm. In one case there were 7 fragments, he sutured the two larger fragments and then circumferently looped the patella.	In one case used lumbar anæsthesia; in the other cases, general anæsthesia. No Esmarch. Horseshoe "U" or "Y" shaped incision used. Blood clots washed out with normal salt solution. In old fractures, freshening of surfaces. Fragments silver wired. Catgut suturing of ligamentous apparatus.	Excellent result in 20 cases, in one case, ankylosis. In one case a silver wire suture escaped through inflammatory fistula. In another case it had to be removed. In several of the cases subject to X-ray examination, at a later period it was seen that the wire was either torn or ruptured, and in one case three pieces of the wire had escaped in the posterior portion of the articulation.

127. Pilcher, L. S. Long Island Med. Jr., 1907, vol. 1, p. 516. 38 cases. Demonstration.			Among other skiagrams he showed two demonstrating two different healed fractures at different levels in the same patella	In 21 cases wired bone. In 17 cases chromic gut sutures applied to periosteum and capsule after clearing out blood clots from joint, and removing from the fractured surfaces the apron of aponeurosis universally present.	In cases exhibited to the Brooklyn Surgical Society restitutio ad integrum both as regards contour, tissue and function was perfect.
128. Pearson, L. W. Long Long Island Med. Jr., 1907, vol. 1, p. 518.	Male, 37 yrs.	10 days.	Right patella was fractured transversely. Upper fragment drawn upwards $\frac{3}{4}$ of an inch.	Transverse incision above patella. Longitudinal incision on each side produced a flap. Bone bored and sutured with kangaroo tendon. Capsule sutured with catgut. No drainage. Joint cavity irrigated.	Good results.
129. Murray, Jno. The Med. Press, London, 1907, vol. 134, p. 149. Operation for wiring fractured patella.	Male, 30 yrs.	4 days.	Fell heavily to the ground. Right patella fractured transversely, $\frac{1}{4}$ inch separation between the fragments.	Elliptical incision with convexity outward. The remains of the torn quadriceps tendon which overlapped the edges of the fractured surface were carefully elevated so as to allow the surfaces to come into contact. Each fragment was drilled with a bradawl and a silver wire passed with which the fragments were accurately approximated. A few silk sutures were inserted so as to bring the torn ends of the quadriceps extensor together.	A fortnight after operation, patient was able to flex his knee through 45 degrees. He was able to get up a few days later.
130. Turner. Lancet, 1907, vol. 11, p. 1540. Demonstration.	24 yrs.		Fracture of patella. While walking, fell and broke bone at same place as six weeks previously. First fracture treated by osseous wiring.	Operation repeated after second accident. Sutured at the end of six weeks.	Patient now has perfect joint.
131. Stimson, Lewis A. A Practical Treatise on Fractures and Dislocations, Philadelphia, 1907, Lea Bros. & Co. Over 200 cases.	In these cases, Stimson employed the open operative method. He has not seen one case in which the fragments separated under use, but several have come back in the 3d or 4th month with refracture caused by a fall. He has frequently done the operation under local anæsthesia. He does not touch the tissues. Does not use drainage. Makes incision in median line slightly overlapping the two fragments. Washes joint out thoroughly with warm sterilized salt solution. The fragments are drawn snugly together with hooks, the fringe adjusted and two or three catgut sutures placed in the periosteum along the edge of the fracture or a single silk or stout catgut suture passed through the tendon and ligamentum patellæ, so that its two strands lie in front of the bone. Sometimes additional sutures are placed in the rents in the lateral expansions close to the bone. (Complete immobilization for one month.) All cases but one recovered with very close union. All but one seen three months after the operation had good use of the joint. In this one case, 3 months after the accident, the patella was freely movable. Union was close but flexion was limited to 30 degrees.				
132. Ransohoff, Dr. Joe. Jr. Amer. Med. Assn., 1906, vol. 47, p. 1177. The treatment of fractures of the patella. 18 cases.				In 14 cases, sutured the fragments 5 times with silver wire, 9 times with kangaroo tendon. 4 cases of circumferential suturing of patella. Sews fibro-periosteal tissues with catgut.	In two cases considerable ankylosis remains. In one case, death resulted from infection.
133. Hessert, Wm. Surgery, Gynecology, Obstetrics, 1907, vol. 5, p. 477.		Male.		Incision with convexity downward; swabbed off blood-clots from the articular cavity by aid of gauze sponges. No irrigation. Patella circumferentially looped with catgut or aluminum ligature. Carefully sutures the lateral tears in the capsule. Early mobilization.	Very good result. Patient suffers no inconvenience, except when going downstairs.

	Age, Sex	Interval between Injury and Operation	Clinical Conditions Present	Operative Procedure	Results
134. Baccus, Victor J. Illinois Medical Journal, March, 1909. Discussion and personal report. Case I.	Male. 41 years.	Operates as soon after the accident as possible. All his cases were operated on within 2 hours after the accident. He says: "The earlier the joint is put in a condition to repair the earlier the union."	Struck on knee in falling off from car. Transverse fracture of patella at about its middle. Small fragment removed from joint. Diastasis 5 cm.	Semilunar skin flap convexity downward. Removal of blood by sponging. Circumferential wire-looping of patella. Slight gauze drainage at angle of wound.	Primary union. Patient up at 4th week. Unrestricted motion.
Case II.	Male. 57 years.	Right patella. Two years before patient had sustained fracture of left patella.	Transverse fracture of right patella. Hæmarthrosis. Fringes of soft tissue between fragments.	Schleich's local anæsthesia (weaker solution). Patient had a marked valvular endocarditis. Same technique as above.	Primary union. Up in six weeks. Good functional result.
Case III.	Male. 46 years.		Fell striking knee. Transverse fracture of right patella.	General anæsthesia. Hæmarthrosis. No interposition of soft parts. Diastasis 3 cm. Technique same as above.	Good functional results. Slight restriction of full flexion. Encircling wire removed after 6 weeks.
Case IV.	Male. 42 years.		Transverse fracture of right patella. Lost his balance in getting off car. On attempt to catch himself fractured patella.	Same technique as above. Posterior wall of prepatellar bursa interposed between fragments. Joint cavity full of blood.	Primary union. Patient was allowed to get up on the 12th day and to walk on crutches. Wire removed at end of 6 weeks. Full restoration of function.
135. Wm. R. Fuller. (In discussion and personal report.) Case I.	Male. 29 years.	5 days.	Kicked by a horse. Transverse fracture of right patella. Fringes of the aponeurosis occupied a position between bone fragments.	Semilunar incision convexity downward. Irrigation with normal salt solution. Fringes of aponeurosis were removed. Edges of patellar fragments approximated by repairing the lacerated soft tissues. No drilling of bones. Aponeurosis sutured by heavy catgut. Leg dressed in usual manner. Plaster cast for 6 weeks.	Bony union and functional result almost perfect.
Case II.	Male. 40 years.	At end of a week.	Fell striking on his left knee. Fractured patella obliquely. Upper fragment divided in 2 pieces. Aponeurosis torn on both lateral aspects. Capsule much distended with blood.	Semilunar incision. Joint irrigated with sterile normal salt solution. Bony fragments drilled (without success). Aponeurosis drawn together by heavy catgut sutures and by suturing it over the broken fragments of bone, the relation of the bony pieces fairly well maintained. Leg dressed in usual manner. Plaster cast for 5 weeks.	No bony union. Separation of fragments slight. Recovered with fairly useful limb.
136. Bouffleur, A. I. (In discussion and personal report.) Over twenty cases. About 25 per cent non-operative. About 25 per cent subcutaneous wiring (Barker). About 15 per cent open wiring. About 25 per cent peripatellar catgut suture.	Ages 21 to 50. All males.	Operation 2 days to 8 months. Prefers 2 to 15 days. If hæmarthrosis is limited to synovial sac operates immediately, or as soon as tissues react from local contusion. If hæmarthrosis is diffuse, indicating rupture synovial sac and extravasation into thigh, operation deferred until granulations are established.	80 per cent direct violence. 10 per muscular action. 10 per cent compound. Line of fracture. 80 per cent transverse. 20 per cent stellate. 2 cases old, one 2 months, other 8 months with 3″ separation. 1 previously operated, small wire broken. Compound, 3″ separation. 1 case double fracture patella few years before. Refracture of one by muscular action. Other good function present with fibrous union 5″ long.	Non-operative, posterior splint, counter-adhesive strips over protection, elevation 40 degrees, daily light massage. Operative curved incision convexity upwards, evacuation by compression, interposed tissue removed, 20 days catgut suture peripatellar tissues. Plain gauze drain 24 hours, elevation 40 degrees, daily massage after wound is healed. If multiple fragments or open fracture, heavy silver wire placed according to mechanism required. In old cases step incision of quadriceps tendon, with very heavy temporary silk tension suture around fragments in saggital line.	Non-operative. Fibrous union 50 per cent, function good. Some complain of persistent weakness or uncertainty. Subcutaneous wiring — bony union and perfect results. No trouble from wire known of. Believes wire should be removed after 4 to 6 weeks. Open wire suture — bony union 80 per cent, good function in all. Wire removed, 2 cases 18 and 48 months after for aseptic irritation. Open catgut suture — bony union 100 per cent. Perfect function in all.

DEPARTMENT OF TECHNIQUE

TWO UMBILICAL TUMORS OF PROBABLE UTERINE ORIGIN

By SAMUEL W. GODDARD, M. D., Brockton, Massachusetts
Former Resident Surgeon to the Carney Hospital, Boston, Massachusetts

On the surgical service of Drs. Munro and Bottomley at the Carney Hospital, there recently occurred within a few weeks of each other two examples of umbilical tumor, the striking similarity and unusual histological structure of which warrant their publication.

Because of the comparative rarity of these cases the clinical histories are set forth in considerable detail.

Case 1. Miss S., a housekeeper, 44 years of age, and born in New Brunswick, entered the Carney Hospital May 22, 1907. Her family and past history have no bearing on her condition at that time. A year previously, during a catamenial period, she noted some redness and tenderness about the umbilicus; two months later at a similar time a small tumor appeared in the abdominal wall close to the umbilicus. This tumor increased in size but slightly and most of the increase came in the two weeks just preceding her admission to the hospital. The tenderness and pain which at first were evident only during the menstrual periods had been constant for some months, though most marked just before, during, and for a week after menstruation. Her menstrual history is not otherwise remarkable. An abdominal bandage, her only treatment, had given her some relief. There had been some little loss of weight and strength. For two months the tenderness had kept her from her usual work. No symptoms referable either to the gastrointestinal or to the urinary tract had been noted.

About and including the umbilicus was a rather deep-seated, spherical, slightly tender, fixed mass of rather firm consistency and about two cm. in diameter. In the navel itself was a thin, yellowish crust; a sinus could not be demonstrated; the skin over the tumor was not red. Examination of the abdomen was otherwise negative. Ex-

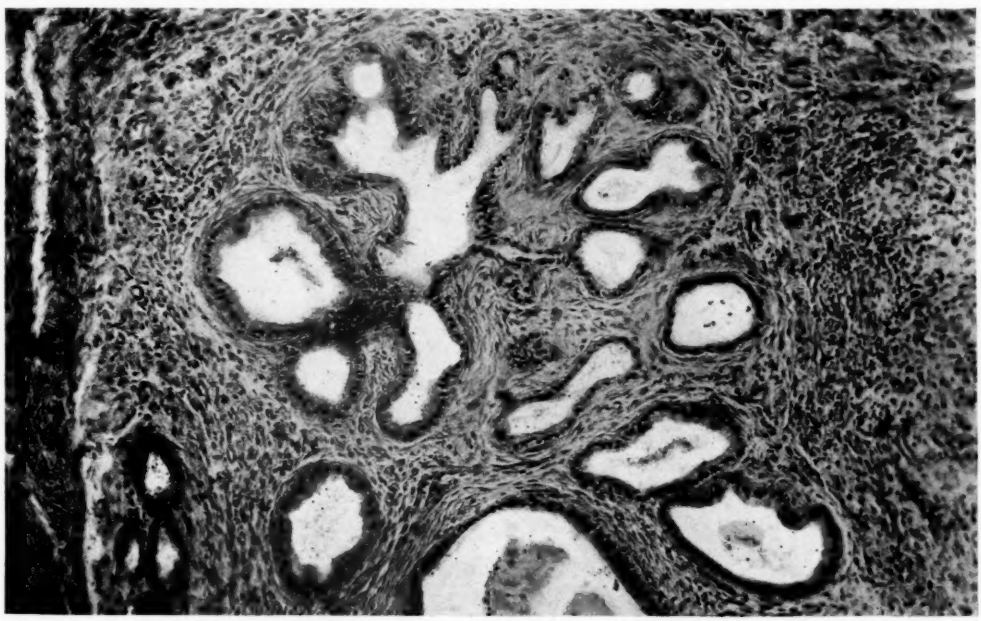


Fig. 1. Shows the general arrangement of the gland structures, and supporting tissues, and varied forms of lining epithelium. X 80 diam.

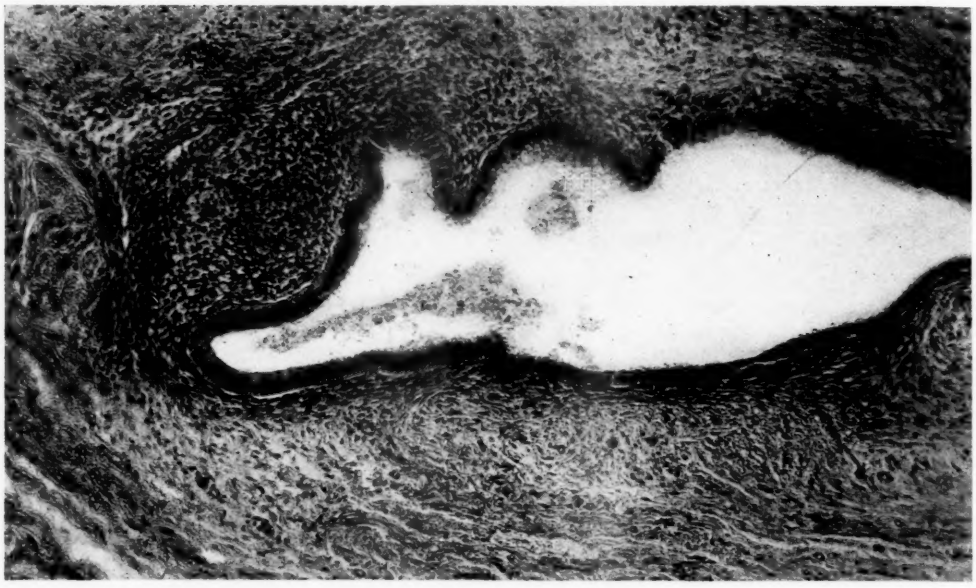


Fig. 2. The outline and arrangement of epithelium of an isolated gland space, its contents and submucous infiltration of dense cellular tissue. Fibrous connective tissue and smooth muscle at its periphery. X 80 diam.

amination per vaginam showed only vaginismus and a moderately retroverted uterus.

On May 23d Dr. Munro excised the growth (including the navel) with a portion of the adjacent peritoneum and sheath of the rectus muscle. The former was not involved in the growth; to the latter the growth was adherent. The convalescence was without note and the patient was still free from recurrence one year after operation.

CASE 2. Mrs. D., a housewife, entered the Carney Hospital, June 23, 1907. She was born in Ireland 42 years before that time and came of healthy stock. Her menstrual history previous to her marriage was entirely normal in every way. Married 17 years, she had borne four children. Following her first confinement she had had a "milk leg."

For six years previous to her entering the hospital, a slight bloody discharge from the navel without pain or tenderness had come with each menstruation. The discharge came only at that time. Independent of the umbilical disorder she had had in the past three years attacks of sharp pain beneath the right costal border accompanied by vomiting, chills, and jaundice.

The patient was rather obese, and showed distinct tenderness beneath the right costal border. At the umbilicus was a small, irregularly shaped papillomatous tumor, 2 cm. in diameter, with three distinct projections covered with normal appearing skin. At the top of the largest projection was a pin-hole opening capped with dried blood. The tumor was soft, freely movable, not tender and apparently superficial.

On June 24th the umbilicus with the tumor was excised by Dr. Bottomley. The tumor was confined to the skin and fat outside the aponeurosis. The peritoneal cavity was opened, and the gall-bladder and stomach regions were explored; these were found normal. Convalescence was uneventful except for the development of malaria on the ninth day, which promptly yielded to treatment. The patient was discharged relieved on July 11th, and when heard from one and a half years later there was no recurrence.

For the microscopical study of these tumors, in the laboratory of Dr. Henry A. Christian at the Harvard Medical School, a large number of sections were taken from different planes and four different methods of staining were used for each section.

So closely do the tumors resemble each other microscopically, that no evident difference between them can be determined. The arrangement and construction both in general and particular is nearly identical. For descriptive purposes a median longitudinal section of Case 2 will be used. To the naked eye it presents an irregularly convex surface covered with true skin. Underlying this at either extremity are what appear to be sweat glands, and in another part, chiefly in the center, are numerous vacuolated structures varying in size from a pin point to a pin head. The intervening structure cannot be definitely determined. Microscopically the tumor is seen to be covered with normal epidermis, but varying in thickness. Below this at either end are numerous sweat glands

thickly grouped, and around these is an abundance of fibrous connective tissue. The vacuolated or glandular structures found throughout the tumor vary in size, and for the most part are of rounded contour while some are elongated. Some, especially the larger ones, are discreet, while others are aggregated into small groups. Some are immediately surrounded by fibrous tissue, while others are embedded in cellular tissue. There are none which appear to have any connection with the epidermis. All the gland spaces are lined with epithelium. They are either devoid of contents, or contain a granular structureless material in which are often found groups of red blood cells. The epithelium varies in the different glands and even in the same gland, from the low, flattened variety to the tall, columnar cells with all the intermediate forms. The tall, columnar variety is for the most part closely compacted with long, narrow nuclei and with no visible cell membrane. Most of them have a distinct top plate, and many show cilia of considerable length and uniformity, while others have only a suggestion of striæ. The cilia in some places are from one-fourth to one-third the length of their cells, and in others their extremities end in a globular, deeply staining tip. At irregular intervals among the nuclei of the columnar cells are larger, rounded and more faintly stained nuclei. In some places the epithelium is distinctly cuboidal, the nuclei clear and rounded, and the whole cell clearly defined. There is a larger group of glands which presents the flattened epithelium. The epithelium lining the glands, whether flattened, cuboidal, or columnar is for the most part in single layers. In some places the glandular epithelium is immediately supported by fibrous connective tissue, but in others the underlying structures are decidedly cellular. The cellular tissue is more compact the nearer the glandular tissue is approached, i. e., the most cellular tissue is found in close connection with the gland spaces. The nuclei are rounded or elongated and deeply stained, the protoplasm and cell membrane not being distinct. In the immediate neighborhood of some of the gland spaces are large hæmorrhagic areas in which large quantities of red blood cells are scattered freely, and intermingled with the cellular structures. These areas seem to have no direct relation to blood-vessels, which are not superabundant or enlarged. The fibrous connective tissue shows nothing of interest throughout the section. There is an abundance of smooth muscle which is closely interwoven with the connective tissue.

The accompanying microphotographs will bring out more clearly the structure and arrangement of the tumors, and emphasize the points mentioned above.

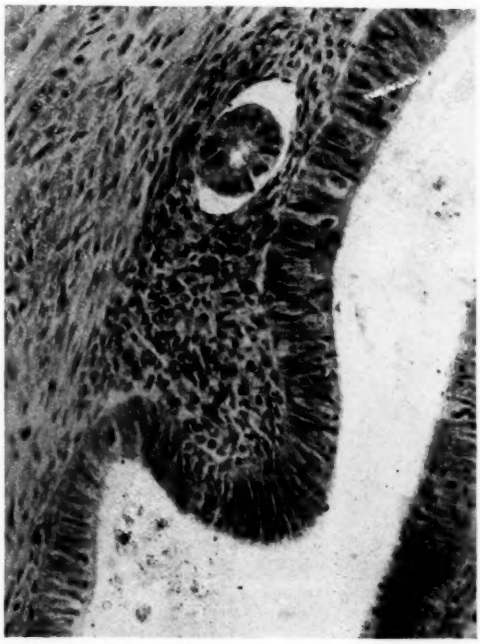


Fig. 3. The character of the epithelial cells and their nuclei become more distinct, also the cellular stroma. Short cilia can be seen above the distinct top plate in places. X 500 diam.

For the sake of comparison as well as from a desire to know the histological structure of the normal umbilicus, sections from 6 normal umbilici, taken at autopsy at varying ages from infancy to adult life, were studied microscopically. There was found no deviation from the normal structure and arrangement of tissue elements. There were no gland spaces except normal sweat glands, nor were there even visible remains of enlarged vessels or increase of fibrous tissue, nor hæmorrhagic areas.

In a review of the literature of umbilical tumors, we find but one case reported which bears any definite relation to the two herein set forth. It is not a parallel case, and was undoubtedly of different origin. It was reported at length by Wullstein in 1893, and he reviewed all the literature including the work of Pernice who had made a complete summary and a rational division of all umbilical tumors the previous year, but who had not met one similar to Wullstein's.

In brief, the case of Wullstein is a combination

Fig. 4. Shows the cilia more distinctly, and brings out the details of the cell structure. X 1300 diam.

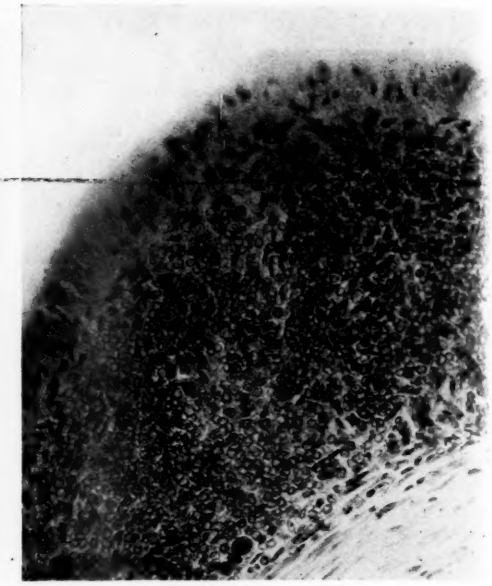


Fig. 5. An area of hæmorrhage into the submucosa. X 500 diam.

of a cystadenoma, and a cavernous angioma. There are two distinct types of gland spaces or alveoli — the first, lined with columnar epithelial cells and containing epithelial cells and secretion in the lumina, is regarded as the result of a backing up or retention of secretion in closely crowded sweat glands. The second type consists of irregularly shaped alveoli lined with endothelial cells, and containing blood closely adherent to their walls. Intimately connected with them are dilated and varicose vessels with marked perivascular cell infiltration. This latter type is looked upon by the author as a result of circulatory disturbance in the tumor, causing varicosities with dilatation of the vessels and formation of large cavernous spaces (alveoli). The old and recent hæmorrhages, found in various parts of the tumor, are thought to be a result of repeated flux hæmorrhages, such as occur at the time of menstruation.

The tumor reported by Wullstein is essentially different both in structure and etiology from the tumors which form the subject matter of this paper. The former showed no ciliated epithelium and exhibited a gland structure that was definite and characteristic; moreover, an entirely satisfactory explanation can be formulated as to the etiology of its two forms of alveoli. Quite the opposite is true of both our cases. As far as can be detected by the microscope the same histological structure appears in both tumors. Furthermore, the clinical picture of one closely resembles that of the other, and though there is no way of proving absolutely their precise nature and origin, both clinical and histological facts point strongly to misplaced uterine tissue as their common starting point.

The type of gland formation, the tall columnar ciliated epithelium, supported by a cellular submucous layer, in which are numerous clusters of red blood cells, and the presence of blood in the lumina of the alveoli, are all very suggestive of uterine tissue. Not alone the pathological findings, but even the clinical stories support our theory. In the first case we find pain, tenderness, redness, and swelling most marked at the menstrual period. The second case is even more convincing with the periodic hæmorrhage at the time of the menstrual period.

Although the tumors in either case did not manifest themselves till middle life, it is safe to assume that they are the recent development of embryonic remains.

The microscopic structure of the tumors, and their periodic change, synchronous with menstruation with actual hæmorrhage in one case, point strongly to their development from misplaced uterine tissue. In this respect these two umbilical tumors seem to be unique.

PLASTIC TUBERCULAR PERITONITIS[1]

Report of an Unusual Case

By CHARLES H. PARKES, M. D.
Assistant Professor of Operative Surgery and Surgical Anatomy, Chicago Policlinic

This condition came to my attention in the laboratory of the Chicago Policlinic. Though it was found in a cadaver and not in the living, I felt it of sufficient interest to trace the history backwards and to make a careful study of the case, which of course included an examination of the rest of the body.

The mass, which will be described here, was located in the left side of the abdomen extending up under the diaphragm to about the level of the tenth rib above, and below to the level of the anterior superior spine of the ilium, on the left side to the abdominal wall and on the right to the bodies of the vertebræ.

By inspection the mass was about the size of an ordinary stomach and in fact at first seemed to be the stomach in an abnormal location. The surface was glistening, smooth, and to the naked eye, entirely free from tubercles. There were irregularities over all, and these appeared like coils of intestines within a large, thin hernial sac.

The mass was somewhat movable, but upon closer examination was found to be adherent to the left and the posterior abdominal wall. Above, it seemed to lose itself in the transverse mesocolon, entirely obliterating the fossæ around the duodeno-jejunal junction; below it was free and intact except at a point where the inferior mesenteric artery presented itself. At this point there was a foramen about three-fourths of an inch in diameter, through which escaped the ileum. From this point to the ileocecal junction there remained about one foot of the ileum, free in the abdominal cavity. Above the mass, and resting upon it, part of the jejunum was plainly seen, and later upon careful dissection this portion of the intestine was found to enter the mass from above.

Fig. 1 shows the sac in position just as found, with the other organs in the abdomen in the position they occupied when the abdomen was opened. Upon incising the sac it was found to consist of three distinct layers, easily separable and joined together by fine, friable filaments of connective tissue, as if the layers had been glued together by exudate, the serum having become absorbed. Inside of the sac was found all of the small intestines except the duodenum and the upper three inches of the jejunum and about the last one foot of the ileum.

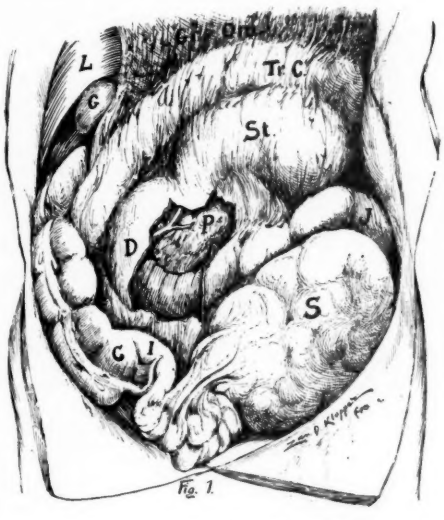


Fig. 1.

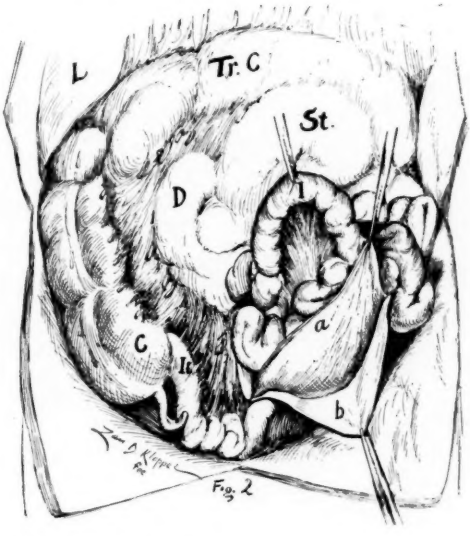


Fig. 2.

[1] Read before the Mississippi Valley Medical Association, October 9, 1907.

The intestinal loops within the sac were free from adhesions and also macroscopically free from tubercles or nodules of any kind; the mesentery was entirely intact and normal, except, that at one or two points there were a few miliary tubercles. Under the peritoneum could be palpated small gland-like nodules about the size of a pea. These nodules upon section and microscopic examination proved to be retro-peritoneal lymphatic glands which showed a marked round-cell infiltration, abundant leucocytes and many distinct tubercles with giant-cell formation.

A piece of the sac itself was sectioned and the slide under the microscope showed well organized connective tissue with scattered leucocytes, and endothelial cells coating both inner and outer sides.

The sac was found to begin about three quarters of an inch up on the mesentery and was not a misplacement of the parietal peritoneum, the parietal peritoneum being found to continue on to the small intestine and to become visceral, with the sac leading off from it.

Dissection to examine the abdominal contents above the sac and their relation to it showed the stomach normal and above, with the duodenum and the transverse mesocolon discernible. In fact it was possible to make out the ligament of Trietz.

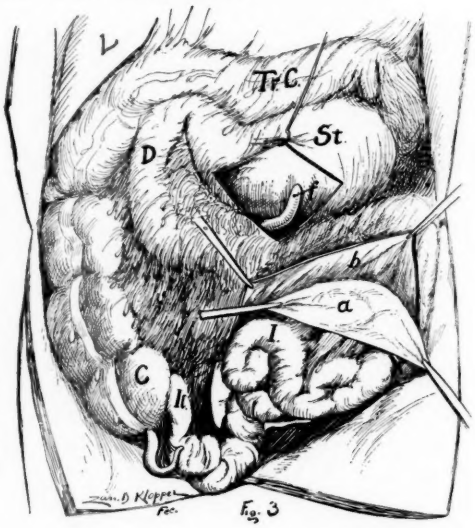
The jejunum led into the sac about three inches from and to the right of the ligament of Trietz and consequently below the transverse mesocolon. By palpating through the foramen of Winslow down behind the stomach to the transverse mesocolon, there was found no communication between the lesser and greater peritoneal cavity.

Fig. 3 shows a large sized sound placed into the lesser peritoneal cavity through the foramen of Winslow, and the end of this sound is seen showing through an opening made in the transverse mesocolon below the stomach. This distinctly shows the transverse mesocolon was intact above the mass.

The liver, gall-bladder, and ducts showed no adhesions or abnormalities. In fact, in the abdomen, the large sac above described was the only abnormal condition present, except that around the appendix and its mesentery were found strong bands of adhesions. Here, however, no tubercles were to be identified.

In the examination of the rest of the body nothing of interest was found except in the lungs, left epididymis, and left knee.

The left lung was one large tubercular abscess, the entire left chest being full of pus. The right lung showed several large sized tubercular cavities.



The left knee, when exposed, was found full of tubercular deposits and granulations and the ends of the bones were necrotic. In the left epididymis was a bean sized nodule undergoing caseation.

The clinical history of the case showed long continued cough, tubercular bacilli and pus in the sputum, loss in weight and other manifestations of tuberculosis of the lungs.

So far as the history went there was no evidence of any abdominal difficulty, though the findings around the appendix would lead one to suspect that, at some time during life, the patient must have undergone a severe attack of appendicitis. But so far as the sac which is described in this paper is concerned there were absolutely no clinical evidences.

Whether or not this mass could have been palpated or whether whatever slight abdominal symptoms that may have existed were due to it or to the mass of adhesions around the ileocecal valve it would be impossible to say. At any rate, on account of the pathological findings in the abdomen as well as those in the lungs and other parts of the body, no other conclusion seems possible than that this pseudo-tumor is the result of plastic fibrinous circumscribed tubercular peritonitis and not an embryological deformity or a condition of retroperitoneal hernia as might appear to be the case upon first inspection.

This truly remarkable condition clearly shows how great are the encysting possibilites of this infection of the peritoneum and how strange a form adhesions in the peritoneal cavity may assume in the natural process of repair.

SOME PRACTICAL POINTS IN THE APPLICATION OF THE BISMUTH PASTE IN CHRONIC SUPPURATIVE DISEASES[1]

By EMIL G. BECK, M. D.
Surgeon to the North Chicago Hospital

In this communication I shall omit all theoretical considerations of the subject. In order that my points be better understood I shall here repeat my conclusion of a paper read before the International Congress on Tuberculosis last fall.

CONCLUSIONS

1. A successful surgical operation for tuberculous sinuses or fistulæ depends principally upon an exact knowledge of the extent, direction, and number of sinuses before the operation is undertaken.

2. Radiographs obtained by previously injecting the sinus with a bismuth paste show distinctly the origin and extent of sinuses. Such radiographs should always be taken before an operation is decided upon.

3. Tuberculous sinuses, fistulous tracts, abscess cavities, including empyema, can be cured by injecting them with a 33 per cent bismuth-vaseline paste and in most cases surgical operations become unnecessary.

4. The formation of fistulous tracts may be prevented by opening cold abscesses, evacuating the fluid and immediately injecting a quantity (not exceeding 100 grams) of 10 per cent bismuth-vaseline paste and not sealing the opening.

5. When sequestra are present, the injections should be tried for a reasonable length of time and risky operations should be reserved as a last resort.

6. Bismuth subnitrate is a bactericidal, chemotactic substance which is slowly absorbed and slowly eliminated. Injections up to 100 grams of the 33 per cent paste produce no toxic effects. In large doses, it may produce symptoms of intoxication, such as ulcerative stomatitis, black border of the gums, diarrhœa, cyanosis, desquamative nephritis, and loss of weight.

7. While these injections are effective in all suppurative sinuses and cavities, those of tuberculous origin respond to them more readily.

8. The secretions from sinuses change their character after the injection, becoming seropurulent or serous and micro-organisms gradually diminish and often disappear. Tubercle bacilli are no exception.

9. This method of treatment is applicable to the suppurative accessory sinuses of the head.

10. The patients regain their general health and gain rapidly in weight after the sinuses are closed.

Since last October we have made very few changes and such modifications as have been made only simplified the method.

After two years' employment of it, and careful observation, I noted that there is a class of cases which react promptly to this bismuth treatment, while a second variety prove quite refractory. It is not always possible to tell beforehand to which category a case belongs, but the first injection usually decides it.

If the discharge changes its character from a purulent to a serous, the sinuses will usually heal with remarkable promptness, and often after the first injection. Whenever the discharge remains purulent, the outlook for closure is not promising.

We endeavored to ascertain the causes which govern the fate of these cases, but have so far discovered only a few reasons why some cases will not yield to this treatment, while others will heal with surprising rapidity. A sequestrum at the bottom is the most frequent cause of failure. I have encountered only two cases in which a sinus has closed in spite of a sequestrum. Another cause of failure is imperfect technique or the impossibility of filling all ramifications of the sinuses at one time. In such cases a part of the tracts will heal, but soon will be reinfected from some communicating pocket which had not been filled with paste at the first injection. This, of course, leads to reopening of the sinus.

One would expect that the very old and neglected cases would not be favorable for the treatment. To our surprise, we found the cases which were considered the most hopeless, proved to be the most favorable. The old neglected and many times operated cases which were nightmares to the surgeon proved choice material to show what could be accomplished by this method. Sinuses of twenty years' steady suppuration, with a history of ten to fifteen operations, have healed after two or three weeks' treatment. A case of empyema in

[1] Read before the Surgical Section of the St. Louis Medical Society, April 24, 1909.

which a rubber tubing had drained the cavity for thirty years, discharging two to three ounces of pus daily, was closed within two months, while a recent case would not yield so readily to this treatment.

In acute conditions the injections have not proven very useful, although some very gratifying results have been reported. I have been conservative in its application in acute cases, having noted some aggravation after its use in some cases.

The most important change we have made in the treatment is the almost universal application of paste No. 1, consisting of 33 per cent of bismuth subnitrate, 67 per cent of vaseline and only in exceptional cases using paste No. 2, which contains wax and paraffin. I found that with paste No. 1 I obtained the best results and furthermore, that it did not require frequent reinjections. As a rule, I injected the cases and then waited fully a week. If the case showed marked improvement, I refrained from further injections and applied only daily dressings. If after one week the character of the discharge and its amount did not change materially, I reinjected with a larger quantity, expecting that this time the paste would reach all the sinuses. The injections were then repeated every three to five days until the sinuses closed. If after two or three months no improvement followed, then the cause of failure was searched for. As a rule, a sequestrum was the cause of failure and after its removal the sinus promptly closed.

About 70 per cent in our series healed without any surgical interference. The remainder were treated surgically before the injections would be effective or, if the diagnostic method of bismuth paste by means of radiographs proved to us the futility of an operation, the case was considered hopeless. Only 6 per cent of cases in a large series were finally given up as hopeless.

During the past five months most cases coming under my care were of the surgical variety, the paste treatment having been tried on them by physicians without success. In 75 per cent of these cases, branded by others as hopeless, I have been able to ascertain the cause of the failure, and in half of this number I have been able to remove the cause of failure and obtain perfect results by proper surgical means, followed by the injections.

The causes of failure were manifold. In one referred case the radiographs disclosed the presence of a one inch probe tip within the shaft of the humerus, while in another case the operation on the humerus revealed the presence of a rubber tubing, three inches long. Error in diagnosis, such as mistaking a tuberculous abscess of the sacrum for hip joint disease, with subsequent operation of the hip, is an example which led to failure, but promptly closed with injections of paste.

The development of technique, the taking of stereoscopic radiographs, before and after injection, the personal supervision of the cases, and accumulated experience will determine in a large measure the final results. The patients should, if possible, be kept at the hospital, but should be allowed to be outdoors almost all day, if they are unable to walk, they should be put on cots in the sunshine.

The death rate has been extremely small. In a report of 192 cases last October I recorded three deaths which occurred in a period of one year. One case of old spondylitis where paraplegia with incontinence of both urine and fæces had existed for a long time, was injected by a Western surgeon, and patient died eighteen hours later. The second case, 67 years old, was a gentleman in whom large quantities of bismuth had been injected by a country practitioner, and produced typical symptoms of bismuth poisoning, from which he, however, recuperated, but died two months later from nephritis due to septic infection of the injured wrist. This case is reported in the Journal of the American Medical Association, Jan. 2, 1909.

The third case died four months after closure of an abdominal fistula of long standing following laparotomy. The cause of death has not been ascertained, since the physician in charge did not get permission to perform an autopsy. The symptoms noted were those of a severe gastroenteritis. Personally, I suspect that death in this last case was due to long continued bismuth absorption.

In a communication published on January 2, 1909, in the Journal of the American Medical Association and the New York Medical Journal, I pointed out the danger of bismuth poisoning. These papers were issued as a warning to the profession, because we realized that large quantities of this paste injected into cavities and left there for more than four weeks produced symptoms of poisoning similar to those of the mercurials.

One fatal case, due to the injection of a psoas abscess in a small child had then been reported by Eggenberger of Basel.

Since then a fatal case at the Cook County Hospital, Chicago, and several cases with recovery, have been reported. I must consider myself fortunate in having had no fatal poisoning in my series of cases. I had no one to warn me against causing this complication. I think it was mere luck to have discovered and recognized it in my first case early enough to prevent its further progress. In a case of empyema I injected 720 grams of the paste and left it in the cavity for six weeks. Notic-

ing a blue discoloration of his gums and a loss of one pound a day in weight, and a slight cyanosis and desquamative nephritis, I began to search for the cause, and found in the literature a case with these symptoms reported by Kocher twenty years ago, in which he dusted fresh wounds in goiter operations with bismuth subnitrate. I decided at once to evacuate the mass from the chest. By injecting a pint of warm olive oil into the pleura through the sinus and leaving it for twenty-four hours, the paste dissolved and formed a grayish liquid substance which was removed with a small suction syringe next morning. All symptoms disappeared within ten days and the patient regained his weight almost at the same rate that he had lost it.

In removing the paste the olive oil method is the rational one. It is a great mistake to employ surgical measures and scraping. The curetting produces a very fine field for the bismuth absorption and aggravates the condition, not to speak of the additional risk of taking an anæsthetic in such cases.

Bismuth poisoning may be prevented, since it is produced only by large doses retained for a long time, and with our knowledge we can watch for its appearance and then by proper methods prevent its progress. The cases will be as rare or rarer than X-ray burns, which in the stage of ignorance were so numerous.

The more recent advances in this treatment are those in the chronic suppurative diseases of the ear, nose, and throat, such as suppuration of the accessory sinuses, chronic middle ear diseases, mastoids, and tonsillar affections. A paper on this subject read by my brother, Dr. Joseph C. Beck, before the Chicago Medical Society will interest not only the specialist, but also the general practitioner.

The results obtained by him compare quite favorably with those obtained by others and myself in general surgery, but on account of the more difficult technique in the application of bismuth paste in the accessory sinuses of the nose, its use will necessarily be limited to the specialists, who are more familiar with the anatomy and accustomed to treat these cavities.

The specialist in diseases of the nose, ear, and throat must see a vast field for the application of the paste, if the results of Dr. Joseph C. Beck can also be obtained by them. Chronic suppurative disease forms the bulk of their work, and their present methods are by no means entirely satisfactory or always successful, and often require severe and dangerous operations in order to obtain results. Although it is too early to have any corroborative reports in the literature, Dr. Beck has already received numerous reports from specialists expressing their satisfaction.

To one who has the opportunity to treat many cases with the bismuth paste, new possibilities for its application will constantly suggest themselves. More than once have I been asked by physicians whether I have tried it in pulmonary tuberculosis. To cure tuberculosis of the lung is an iridescent dream of so many investigators, and the disease is the target of so many new remedies that one would hesitate to announce another new cure for pulmonary tuberculosis, even if he were certain that he had discovered it.

I have given this subject serious consideration, and my views and my experiments will be reported at the next meeting of the American Medical Association.

Recently I have employed the method in lung abscess. I shall likewise report this case, and show an entirely novel method of treatment of these lung abscesses by surgical means, assisted by the bismuth paste.

Whether the bismuth paste should be injected into tuberculous joints instead of iodoform emulsion is another question to which I have to reply very frequently. My usual answer is: "It should not be used for this purpose." Although I have employed it in several cases with success, I have encountered one failure, and I can foresee possible dangers and therefore hesitate to advise it, at least for the present, until some investigations on lower animals will prove it a safe procedure.

It is obvious that the limitations in the use of the paste are not yet defined, and that there is a vast and promising field for further investigation.

Dentists have already tried and have found it satisfactory in the treatment of pyorrhœa alveolaris and fistulæ from caries about the teeth. My brother, Dr. Rudolph Beck, a dentist, has read a paper on this subject before the "Iowa State Medical" meeting of dentists, and the subject was received with enthusiasm and favorable comments upon its efficacy have been given by very prominent members of the dental profession.

There is no reason why the same method could not be applied in the treatment of sinuses in lower animals. Such suppurative processes are very common in horses, and I hope that veterinary surgeons will soon test its efficacy in treating sinuses and chronic abscesses.

It is fortunate that our profession is so conservative in adopting new remedies or new methods of treatment, demanding from the author satisfactory evidence of merit in his new ideas, before even consenting to try them. This conservatism

preserves the well-tested and accepted methods until some real and valuable advance is presented.

The introduction of the bismuth paste in the treatment of chronic suppurative sinuses and empyemas has been somewhat favored, and the chains of the usual conservatism loosened.

Surgeons in this country and abroad began testing the method almost as soon as its first publication appeared in the journals. I do not regard this in any way as a compliment to myself, but ascribe it to the fact that this new method attacked a class of cases so hopeless and discouraging that anything in the way of new treatment was welcome. Furthermore there was not much opposition to the method, no one having claimed any successful remedy for these cases, and again the patients suitable for immediate trial were so willing and so plentiful everywhere that the opportunities for testing were most favorable.

Fortunately, the method proved valuable, judging from the comments upon it from various sources. We have the assurance of its effectiveness from all directions and may therefore now unhesitatingly recommend its use in suitable cases.

It is true that there is danger of bismuth poisoning, and possibility of failure, but the proportion of satisfactory results is so vast that with proper precautions against the toxic effects and with the perfection of technique the method will find many advocates.

In conclusion I wish to advocate a healthful conservatism in the use of the bismuth paste, and appeal to enthusiasts not to carry their experiments beyond the safety line.

There is danger of bismuth poisoning. There is danger of compressing vital organs, such as the brain or the pancreatic ducts. A drop of paste injected into a vein will cause death almost instantly, and in acute conditions it may be harmful. Let us not forget that the bismuth method of treatment of chronic suppurative diseases is not intended to displace all other well-tried and valuable methods, but is to serve as an addition to them, which, owing to its simplicity and its wide field of application will find many adherents.

DIFFUSE SUPPURATIVE APPENDICITIS VERSUS GENERAL PERITONITIS, WITH REPORT OF A CASE

By CHARLES E. HUMISTON, M. D., Chicago, Illinois

I make the following report of a diffuse suppurative appendicitis which occurred in my practice, apropos to an editorial concerning this subject in a late number of the journal. It is chiefly interesting on account of its throwing some light upon the question of how much peritoneum is involved in the class of cases known as diffuse peritonitis and is likewise an illustration of an unusual cause of sudden or rapid death during the convalescence following childbirth.

The patient is one of about five months' pregnancy, in which an acute appendicitis developed. A description of the conditions, operation, and autopsy is abstracted in brief as follows:

Mrs. A. G., seen in consultation with Dr. C. N. Pohl.

A short incision was made above and parallel to Poupart's ligament, separating the abdominal muscles in the direction of their fibers was done, and upon opening the peritoneum there was an escape of turbid fluid. *Cautious exploration failed to reveal any limiting adhesions*, so the operation was completed by inserting a split-tube and gauze drain and the patient put to bed with the head and shoulders elevated.

The discharge from the drain was rapid and profuse at first, gradually lessening from day to day and becoming thicker as the quantity diminished.

The after treatment consisted of the rectal and subcutaneous administrations of normal salt solution, the withholding of food and medicines by mouth, and absolute quiet and rest. At the beginning of the third day liquid nourishment was given, cautiously at first, then more freely.

On the second day spontaneous expulsion of the child, quickly followed by the placenta, occurred. The baby was still-born. The uterus contracted promptly and normally, and there was a comparatively small loss of blood.

The abdominal distention became more marked, and the general conditions failed to improve. During the day the patient vomited several times, but after washing out the stomach this symptom subsided. On the third day the bowels moved spontaneously, and from this time on the dis-

tention grew less and less — the patient became hungry and took increasing amounts of liquid nourishment. Along with the subsidence of the abdominal distention, the tenderness and rigidity diminished and there was marked daily improvement of these conditions.

The morning of the fifth day found the patient's condition very satisfactory. She had rested well all night, the bowels had moved freely several times. She seemed bright and cheerful, looked much better in every way. The morning pulse was 80, the temperature 99, and the respiration 28. At 9 A. M. there was a sudden attack of dyspnoea with a sense of pain and distress in the chest. The patient thought she was dying. The face quickly became cyanotic and the patient was bathed in a cold perspiration. No pulse could be felt at the wrist. The respiration was rapid and appeared to be free, but the patient complained of her inability to get air.

The pain was not definitely located; some of the time in the right side, then in the left side, and again precordial. The principal distress was the marked dyspnoea.

The patient rallied from the initial shock somewhat. The dyspnoea however continued, and the pulse-rate remained high, while the temperature continued subnormal to the end.

The patient took milk and other liquid nourishment freely; did not vomit at all; the bowels moved naturally, and the mental condition was clear.

She died June 26, 1907, just 48 hours after the onset of the pulmonary symptoms.

The following morning an autopsy was done, the record of which is here appended in brief:

Post-mortem Examination by Dr. C. E. Humiston. Present: Drs. C. M. Pohl and Chas. Reiterman. Date June 27, 1907.

Peritoneum. Some adhesions between parietal peritoneum and the omentum in the median line from the umbilicus downwards. This condition is quite marked in the right lower quadrant of the abdomen.

The region immediately about the stomach is free from evidence of inflammation. There are numerous fibrinous adhesions about the gall-bladder, and generally along the under surface of the liver external to the gall-bladder. Soft friable adhesions are seen between the descending colon and the parietal peritoneum, as high as the splenic flexure. Coils of small intestines are here and there united by fibrinous adhesions which break up without perceptible resistance. Lower in the abdomen the adhesions are denser and more abundant. The coils about the fundus of the uterus are somewhat firmly united both to that organ and among themselves. In the region of the appendix the adhesions are separated only after using considerable force. The appendix is found near the center of a large mass of matted intestines, omentum, and inflammatory lymph, and into which region the rubber drainage tube penetrates.

The appendix is about three inches in length, its direction downward. About its middle is seen a perforation, and the organ distal to this point is greenish black in color, soft, and shapeless.

The lesser peritoneum and the pancreas appear normal. The spleen appears about double the usual size, and is soft and pulpy. The liver seems large — its cut surface dark, and its vessels contain much dark blood.

No areas of suppuration or other gross pathologic change noted.

The gall-bladder is small and short, and contains about one ounce of yellowish turbid fluid.

The uterus, tubes, and ovaries, normal.

Pleuræ, pericardium, and heart, normal.

The right lung crepitates throughout and presents nothing unusual.

The left lung shows a dark discoloration for about the upper two-thirds of its lower lobe. Upon dissection of the left pulmonary artery a tough fibrinous clot, one and a half inches in extent is seen occluding the branch supplying the discolored region already noted. This clot is adherent and upon removal is seen to consist of a light pink fibrinous material, quite firm and not easily torn, and a remainder of dark red clotted blood. The vessel distal to this point contains a soft cylindrical clot easily expressed.

The lung tissue of this area is dark reddish-brown in color, crepitates only feebly, and portions of it sink when dropped into water. The rest of the lung presents nothing unusual.

Post-mortem Diagnosis:

1. Diffuse (plastic) peritonitis involving three-fourths of the abdominal cavity.
2. Localized suppurative peritonitis.
3. Gangrenous appendicitis (with perforation).
4. Cholecystitis and pericholecystitis.
5. Pulmonary embolism with infarction, left lung.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

A REGULAR MEETING WAS HELD APRIL 2, 1909, WITH THE PRESIDENT, DR. A. E. HALSTEAD, IN THE CHAIR

Dr. F. Gregory Connell, of Oshkosh, Wisconsin, read a paper entitled "Some of the Principles of Intestinal Suturing." (See p. 138.)

DISCUSSION

In the absence of Dr. E. Wyllys Andrews, who was appointed to open the discussion, the president asked Dr. John E. Owens to do so.

Dr. OWENS said: The subject which has been presented to us this evening is doubly important, owing to the study which has been given it and the experience which has been brought to bear upon it. However, after a number of years one gets wedded to one method of dealing with intestinal wounds by suturing. First, the mechanical method I might speak of, which at one time I looked upon with much favor. I still have several intestinal clamps, so-called, by means of which end-to-end suture was very easy indeed. These clamps hold the intestinal ends in the relation which you desire during the whole operation, and the operation is thus rendered comparatively easy. Later, we were taught by the authors of articles which appeared in our medical journals that there were better methods; that the ordinary suture was the best. Well, I have used the ordinary suture with a good deal of satisfaction, but not through and through suture. I am very glad to hear, and to learn from this paper — and I have heard Dr. Connell's views expressed by him before — that this is a safe suture to use. It is certainly a method which strongly maintains the ends in approximation without any great risk. I think a good deal of the peritoneum in regard to sutures. We used to use the Lembert suture very much, and the healing is rapid. I have been obliged a number of times to open the abdominal cavity within twenty-four hours after an operation and have found threads of gauze sponge entirely covered over, so that while we could see them, they could not be felt, as they had quickly become covered with a translucent serous exudate.

This function of the peritoneum is a valuable element in the success of any kind of suture of the intestine and it doubtless prevents leakage and septic invasion.

I think we all appreciate the value of this paper whose author has given us the principles and methods, and from these he has drawn useful deductions which will guide us until something better is brought forward with regard to intestinal wounds and sutures. Dr. Andrews uses this suture almost entirely, and thinks it is the best suture method we have at present.

DR. JACOB FRANK: I remember very well when Dr. Connell conducted his experiments on dogs, and at that time he came over to my place and showed me how to use this method. The dogs recovered from the operation, and so did those on which I operated with my method.

He has gone over the ground so thoroughly that there is very little left for me to say.

There is one particular point of which I desire to speak, namely: he claims for the diaphragm a purpose with which I cannot agree. When the suture method first came out this diaphragm was considered a very bad thing and was against suturing. Now, I see the doctor is ready to overthrow that and says in his argument that it prevents infection. I disagree with him in that respect. He has not shown us in which way this diaphragm can possibly have that effect. My experience with the suture method has been mainly in side-to-side anastomosis; that the diaphragm in a dog, whose intestines were not completely emptied, the fecal current would go against the diaphragm and often stop there, and if there happened to be a piece of bone in the dog's intestine, there would be obstruction from that. I agree that the Connell suture is a very good thing and is giving very good results; but still it is not an ideal method. An ideal method of intestinal suturing, expecially in end-to-end work, should leave the patient with as normal a caliber of this intestine as he had before the operation.

I have made microscopic sections of the Connell suture and of other sutures, and also of mechanical devices, and I find that one of the strong points of

the Murphy button is that it leaves the tissues in juxtaposition. This is done by the mechanical spring. When we operate on dogs with some means that will leave the tissues in juxtaposition, the peristaltic wave of the intestine will not stop there like it does when you produce a diaphragm. I have noticed this particularly in operating on dogs. The ideal method for end-to-end anastomosis must be one that will leave the tissues in juxtaposition, and unless it does, it is not ideal. This is a new feature connected with the operation, that the spur keeps the sutures aseptic or from producing peritonitis. Personally, I do not believe it. Otherwise I agree with everything Dr. Connell has said.

One point which I wish to emphasize is this, that the man who is not in the habit of operating constantly cannot use the Connell suture successfully. For side-to-side anastomosis I have discarded all mechanical means. I have discarded all mechanical means for gastroenterostomy; but I think that mechanical means of some kind for end-to-end anastomosis will not be purely historical, and the only method I hope some day for the suture will be also the Connell suture. The others will be historical, unless some better method will take its place.

DR. T. J. WATKINS: I have little to say except to endorse Dr. Connell's paper. I agree with him in all details. Personally, I am extremely fond of the Connell suture. Theoretically, what he says about through and through sutures is an absolute fact. It is impossible, especially in the small intestine, to put in a suture of any depth without puncturing the mucous membrane. He emphasized one extremely important point, and that was the necessity of putting non-absorbable sutures for the through and through use, on account of the secretions digesting the absorbable material too soon. This is especially true with the small intestine. Probably it is not so true of the large intestine.

I think Dr. Connell's point in regard to the diaphragm is well taken in that this diaphragm remains for a few hours until there is a plastic exudate at the sero-serous approximation; then, after that the action of the diaphragm in regard to protection or in regard to any danger can have but little importance. The diaphragm very soon atrophies or becomes necrotic. I think the point Dr. Connell made was probably one of the most important, and one that is often neglected in surgery, and that is, the firmness with which the knots are tied. A knot that is tied so tightly as to cut off circulation is sure to produce necrosis. One can say with a great deal of certainty that the slight suppurations in wounds are quite as often the result of tying knots too tightly as they are in using bad suture material. This is true in tissues that have bacteria, such as the skin, and it must be so in tissues like the intestines which have bacteria, but would not apply in absolutely sterile tissues.

DR. A. E. HALSTEAD: Two years ago last February I operated upon a case of obstruction due to cancer of the descending colon. The ileus was not due to the primary growth in the colon, but to an angularity of the small intestine produced by adhesions of a loop of intestine to the growth in the colon. Double resection was performed; the Connell suture being used to unite the divided ends of the intestine. The patient recovered, but later developed metastasis in the liver and died a few days ago. An autopsy was made and the intestine examined. It was with difficulty that the site of the resection could be found. There was no sign of the diaphragm that has recieved so much attention. Neither was there any constriction of the lumen of the intestine.

DR. CONNELL, closing the discussion: In regard to the diaphragm which has been referred to by Dr. Frank, I desire to make a drawing, which will show its valve-like action (drawing on blackboard). With distention from gas or from pressure by any of the contents of the intestine, the diaphragm is forced one way or another, it is forced over to this side, like that (indicating) or to the opposite side.

With marked intra-intestinal pressure, the diaphragm will assume the shape I show now, and as the force is applied here (indicating) the two serous surfaces of the inverted cut ends will be held together still more securely.

It is this diaphragm that makes possible the securing of a water tight suture line in dead bowel, and in the living bowel it is this diaphragm that prevents leakage before healing has taken place; and after healing the diaphragm disappears as has been shown in the case reported by Dr. Halstead, and by a specimen in my possession, in which death, due to typhoid fever, occurred 100 days after end-to-end enterorrhaphy, and at the autopsy it was very difficult to find the line of suture.

Intestinal obstruction, due to the diaphragm, should never occur with properly placed stitches. There is a case on record in which a Murphy button was inserted above an enterorrhaphy causing such a diaphragm, and the button passed uneventfully at the usual time.

DR. JACOB FRANK read a paper entitled "Kraurosis, with report of a Case." (See p. 120.)

DISCUSSION

DR. T. J. WATKINS: I have seen a number of cases where there was a good deal of pathology about the vulva, such as Dr. Frank has described. One very noticeable case was where the ovaries were removed from a woman about 32 years of age, which was followed by extreme atrophy. The atrophy was so extensive and contraction so great, that when she came under my observation the vaginal opening would hardly admit anything larger than a good-sized lead pencil.

This subject I have naturally thought a good deal about as much has been said in the literature about it for a number of years, and I have been somewhat disturbed by none of the descriptions saying anything that was peculiar to this disease. All of the pathology that has been given and all of the sections that have been illustrated are found in infectious diseases of the vulva. The round-cell infiltration which is spoken of indicates very much that it is an infection.

Another thing that points to the disease being an infection is the frequency of pruritus, the presence of an irritating discharge. Later on this pruritus may disappear as the atrophy continues and the nerve endings are destroyed. So when a patient consults us it may be rather late in the disease and the history does not show pruritus. Most of these cases occur after the menopause and are attended by rather extensive atrophy. We all know that there is marked atrophy of the vulva following the menopause, and in some cases it is much more marked than in others. The opinion that the disease is an infection, with the formation of a large amount of scar tissue and with a good deal of degeneration, and the fact that there is hypertrophy in some places and atrophy in others, depending upon the age of the inflammatory exudate, is upheld by Veit who, I think, has possibly said the most about it. He looks upon it as an infection. There were a number of these cases seen in Martin's clinic, and sections of tissues were removed which were carefully studied by Orthmann and Peter, and their conclusions were that it was an infection. It seems to me, that until something is shown which brings out something peculiar in pathology this disease should be considered and treated as infection, and that the use of the term kraurosis vulva should be dropped.

DR. FRANK, (closing the discussion): Before the case I have described came under my observation, like Dr. Watkins, I thought this disease did not exist, but because he has not seen any of these cases, is no reason why they do not exist. If he gets hold of one and sees it the way I saw it, and operates on it and sees the benefit from operation, he will change his mind. Men like Martin, Veit, Landau, and Reed, who have studied these cases, have written on the subject and tried to find out the cause. Dr. Dudley, of this city, describes the disease and illustrates it in his book. I think such a disease does exist, even though we do not clearly understand its pathology.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF SURGERY

UNDER THE CHARGE OF

JOHN B. MURPHY, M. D.
FREDERIC A. BESLEY, M. D.
WM. C. DANFORTH, M. D.
AIMÉ PAUL HEINECK, M. D.
FRED C. ZAPFFE, M. D.
WM. R. CUBBINS, M. D.
ARTHUR B. EUSTACE, M. D.
FREDERICK G. DYAS, M. D.
M. G. SEELIG, M. D.
GEO. E. BEILBY, M. D.

On the External Roentgen Treatment of Internal Structures. CARL BECK, M. D. *New York Medical Journal*, March 27, 1909.

Dr. Beck reports seven cases of malignant growths in the abdomen that were too far advanced for surgical removal, which he attached to the abdominal wall so as to make them more accessible to the X-ray. These were then exposed to the X-ray with the surrounding structures protected. In three of the cases the results so far have been excellent, but the time that has elapsed since operation is not definitely stated. Four other cases were not successful, some dying as early as the 5th day, the others later.

The author only suggests this as a possible hope for an otherwise incurable case.

Painful Heels. ISAAC D. STEINHARDT, M. D. *New York Medical Journal*, March 27, 1909.

Dr. Steinhardt reports 30 cases of this affection, and considers the etiology to be clear. It occurs most frequently in white men from eighteen to twenty-five years of age, and at this period is usually gonorrhœal, although traumatic cases are on record. At later periods in life, rheumatism and gout are more frequently etiological factors. It is characterized by an exostosis on the under surface of the os calcis, just at or anterior to the tubercle. It is usually in the shape of a spicule that points forward and downward.

The symptoms usually begin with pain in the toes, later localizing under the point of growth as an exceedingly tender spot, which is sometimes so severe as to necessitate the use of crutches.

The treatment consists of an incision down the middle of the heel, the location and removal of the exostosis. Under this method the author has not noted any recurrence in three years. WM. R. CUBBINS.

The Reversion Theory and Classification of Goiter. WM. CARPENTER MACCARTY, M. D. *Journal of American Medical Sciences*, vol. cxxxvii, No. 6, pp. 806.

The author in reviewing the pathology of goiter and in citing cases from the Mayo clinic at Rochester, draws the following conclusions:

1. The process of goiter may be a process of reversion of the thyroid gland to some former function.

2. Hyperthyroidism is a toxæmia, the result of absorption of the products of the hyperactive thyroid.

3. The stimulus causing the hyperactivity may be the same that stimulated the thyroid to activity in primitive man.

4. This stimulus was then probably a normal stimulus to the gland, just as we have normal stimuli for glandular activity in main in his present condition.

5. This stimulus may still be present in food or water, formed through some process in the intestine or in the metabolism of the body, or it may exist in the air.

6. The types of goiter are probably not types but stages in a general process.

7. Goiter may be classified upon a pathological basis as follows:

a. Cystic goiter.
b. Hypertrophic parenchymatous goiter.
c. Papillary cystic goiter.
d. Hypertrophic fœtal thyroid.
e. Fœtal adenoma of the thyroid.

8. Hyperthyroidism always occurs in hypertrophic parenchymatous goiter and papillary cystic goiter and may occur in fœtal adenoma of the thyroid.

A. B. EUSTACE.

Submaxillary Lithiasis. Acute Submaxillitis. Extirpation of the Gland and Calculi. (De la Lithiase sousmaxillaire. Sousmaxillite aiguë. Extirpation de la glande avec les calculs.) SCHWARTZ. *Archives Générales de Chirurgie*, March, 1909.

The patient, a female 43 years of age, for the last ten years has had pain in the left submaxillary region. At first there was simply pain, then a painful swelling, and at last there developed, associated with dysphagia and tumefaction of the submaxillary region, a painful heavy pain in the floor of the mouth. An evacuation of pus by the mouth led to an improvement. The outline of the tumor having the shape and the location of the gland, taken in connection with an induration in the region of the anterior pillar, led to the diagnosis of lithiasis and submaxillitis with abscess formation and pus evacuation in the mouth. The facial was ligated, the gland enucleated and underneath the buccal mucosa were found an abscess and two calculi. Drainage and complete cure followed in three weeks;

the only post-operative incident was a paralysis of the left anterior lip which has since disappeared completely. The cavity containing the calculi was located in the superior border of the gland. The gland was hard and sclerosed; in its center, a small abscess was found.

Histology. We had an inflammation of the acini, a very dense periacinous sclerosis. There were no evidences of fatty degeneration. The calculi, irregular in shape, had pointed projections on their surfaces.

In the etiology of these calculi, the parasitic theory has been invoked. Existing calculi increase the alteration of the already infected salivary ducts. Infection and obstruction lead to the dilatation of the salivary ducts, to sclerosis of the connective tissue, to an atrophy in the parenchymatous tissue, leading in some cases to fatty degeneration. When the calculus is located in Warthon's duct, the infection may not manifest itself but almost always the gland is altered to a greater or less degree. Clinically, the infection evolutes in two periods: during the first period there are attacks of pain occurring in connection with intermittent swelling; in the second period, we have tumefaction with induration and abscess formation. In all cases where the calculi are not accessible and where structural changes are present in the gland the only rational treatment is the extirpation of the gland. By making the incision below the inferior margin of the jaw, a conspicuous scar is avoided. It is always well to drain. The author thinks that partial paralysis, which occurred 8 days after the operation, can be explained by a neuritis of a filament of the facial nerve.

AIMÉ PAUL HEINECK.

Treatment of Aneurisms of the Base of the Neck. (Traitement des anérysmes de la base du cou.) GUINARD. *Revue de Chirurgie*, No. 2, 1909.

For aneurism of the innominate artery Guinard, in fifteen cases, resorted to the simultaneous ligation of the right common carotid and of the subclavicular arteries. The technique of the operation, the operative and post-operative accidents and the therapeutic results are discussed. From the standpoint of technique, he advises the ligation of both vessels at the same sitting. So as to avoid the danger of cerebral embolism the ligature is first placed around the common carotid. If the aneurism conceals the vessel that is to be ligated, if it interferes with the operative procedure, it is retracted to one or another direction. As ligature material, the operator employs indifferently flat silk or catgut. Drainage is not indicated if the operation has neither been long nor laborious. Among the operative accidents to be feared, embolism is the most important. To avoid it, the aneurismal pouch will not be roughly handled and the common carotid will be the first vessel ligated. The author has never ruptured the wall while tying the ligature; has never seen, during the ligation of the vessel, any alarming disturbances due to the anæsthetic.

Among the post-operative accidents mention must be made of cellulitis and of secondary hæmorrhage. These two complications, however, should not occur to an aseptic surgeon. As to hemiplegia following ligation of the common carotid, it can follow only after a septic operation with a resulting ascending thrombosis of the carotid artery, or if there be an abnormal diminution of the caliber of the opposite carotid. The ligation of the common carotid is never followed by accidents when the carotid system of the opposite side is free.

The therapeutic results are as follows: The farther the aneurism is from the arterial valve, the better the results of the operation. For aneurisms of the innominata and of the origin of its branches recent statistics give 100 per cent of cures. In aneurisms of the ascending aorta, the results are very appreciable. The author reports also a case of ligation of the thoracic aorta for aneurism. The circulation in the lower extremities was quickly re-established, but the patient died from anuria. The production of anuria is the only reason why the ligation of the thoracic aorta above the renal arteries is incompatible with life.

AIMÉ PAUL HEINECK.

Cervical Œsophageal Fistula. (Fistule œsophago-cervicale.) MOTY. *Archives Générales de Chirurgie*, April, 1909.

Moty reports a case of cervical œsophageal fistula occurring in a female 20 years of age. The patient was suffering from a tuberculous cervical adenitis. Secondary to the lymphadenitis a phlegmon developed; it was first punctured, then incised. A large incision was made, nevertheless an œsophageal fistula resulted. The patient died with septicæmic symptoms. These fistulæ are of great rarity and of great gravity.

AIMÉ PAUL HEINECK.

The Bacteriology of Acute and Chronic Appendicitis. (Zur Bacteriologie der akuten und Chronischen Appendicitis.) E. FRANKE. *Deut. Zeit. f. Chir.*, b. 96, h. 4.

Franke studied 101 cases of appendicitis from a bacteriological point of view, and summarizes his data as follows:

It is not possible to determine from the clinical picture what types of bacteria are at work, and it is equally impossible to be guided in a therapeutic way, by clinical findings. In practically all cases, however, the early serous peritoneal exudate was sterile. The bacillus coli communis was found in almost every case, but it was often found together with streptococcus pyogenes, diplococcus lanceolatus, and staphylococcus lanceolatus. As a rule, the prognosis is much graver when the streptococcus is present, and much less grave when the bacillus coli communis was present alone. The streptococci and diplococci are much more likely to be found in acute cases, and in individuals under 30 years of age.

Regeneration of the Vocal Cords after Their Surgical Ablation. (Régénération des cordes vocales après leur ablation chirurgicale.) BRIZON. *Archives Générales de Chirurgie*, April, 1909.

Brizon shows that after extensive ablation of the vocal cords the re-education of the larynx is possible. The successful outcome of 22 cases of thyrotomy and

the resection of one cord established the fact that regeneration is often perfect. In the case of Lannois a mobile cord was formed from the epithelium and from the cicatricial fibrous tissue, presenting the usual pearly appearance. In four cases of hæmilaryngectomy there was formed opposite the healthy cord a cicatricial mass sufficing for phonation. After total laryngectomy, a pseudo-glottis is formed. The experimental attempts to regenerate the vocal cords in animals have been unsuccessful and the question will only be elucidated by the careful clinical watching of patients. AIMÉ PAUL HEINECK.

A Case of Dilatation of the Œsophagus Due to Spasmodic Stenosis of the Cardia. (Un cas de dilatation de l'œsophage par sténose spasmodique du cardia.) SENCERT. *Revue Médicale de l'Est*, 1908, p. 678.

This patient, which Sencert had under observation for three years, was suffering from dilatation of the œsophagus secondary to a spasm of the cardia. She had a period of improvement of two years' duration which was obtained by the aid of œsophageal dilatation through the cardia. The spasm recurred and provoked a dilatation of the œsophagus, of greater degree than the previous one. The same treatment brought a cessation of the spasm, re-established the permeability of the cardia and drained the œsophageal pouch. But it is certain that the muscular tonicity of the œsophagus is impaired and if the spasm recurs, œsophageal dilatation will certainly follow. In cases of this kind, if medical treatment be non-productive, Sencert advises the performance of a transmediastinal œsophagogastrostomy. AIMÉ PAUL HEINECK.

The Occurrence and Treatment of Tetany Parathyreopriva. (Ueber vorkommen und Behandlung der Tetania parathyreopriva beim Menschen.) F. VON EISELSBERG. *Cent. f. Chir.*, No. 21, 1909.

Eiselsberg performed 500 thyroidectomies from April, 1901, to June, 1908. In 15 cases the patients showed Chvostek's facial phenomenon (a characteristic early sign of tetany) after the operation, but the symptom disappeared in a few days without treatment. In 10 cases there was well developed tetany, and one of these ten cases died. In every case in which tetany developed, the operation was extensive and complicated, and as a rule, both lobes of the thyroid were attacked.

The best treatment for this form of tetany is the adoption of prophylactic measures, designed to avoid injuring the glandules. In case a parathyroid should be removed accidentally, it should be transplanted immediately. If tetany should develop, in spite of the exercise of due care, then the line of therapy to be followed is the administration of thyreoiden tablets (these tablets are made from both thyroid and parathyroid tissue). If this fails, nothing is left but to transplant human parathyroid tissue into a peritoneal pocket of the patient. This procedure is attended with extraordinary difficulty, both because of the doubtful propriety of taking a parathyroid from a healthy patient, and because of the possibility of failure of the graft. M. G. SEELIG.

Expulsion Per Mouth of the Œsophageal Mucosa after the Injection of Caustics. (Expulsion de la muquese de l'œsophage par la bouche après injection de caustiques.) GILBERT ET A. PHILIBERT. *Progrès méd.*, Feb. 13, 1909.

The cases of massive expulsion of the œsophageal mucosa found in the literature may be divided into two groups. In the first group are included those cases in which a cast of the œsophagus is expelled, having the same form as the organ but consisting only of the mucosa which has desquamated in its entirety. A characteristic of this form is its apparent spontaneity and the absence of an acknowledged or discoverable cause.

The second group consists of cases (they are far more numerous and interesting) where there has been an expulsion of a massive cast showing an envolvement of the deeper layers, the submucosa muscularis. The epithelial tissue itself is destroyed and can barely be recognized. In these cases the expulsion is secondary to the injection of a caustic which has scarified the œsophagus. AIMÉ PAUL HEINECK.

Experimental Investigation of the Relationship of Trauma to the Heart. (Experimentelle Untersuchungen über Herz und Trauma.) KUELBS. *Mitt. aus den Grenz. der Med. und Chir.*, b. xix, h. 4.

There is no absolutely definite knowledge regarding the influence of injuries to the chest on the development of heart lesions. Kuelbs had opened the question anew from an experimental point of view. He proceeded as follows:

With a club weighing about six pounds he struck the chest of the animal experimented upon, one to three times at the spot where the apex beat could be felt. It will be seen that these experiments differ from previous ones made by other experimenters in that the the heart was injured indirectly, the thorax being unopened. In all, twenty-four dogs were used, and of this number two died immediately after the blows were struck. The other animals were killed after a few hours or days. Very extensive heart injuries were found quite frequently and often there was no accompanying injury to the skin or chest wall. The injury to the heart manifested itself chiefly as a hæmorrhage into the valves. Sometimes the hæmorrhage took place into the heart muscle or into the pericardium. In the majority of cases the hæmorrhage into the valves was absorbed. The hæmorrhage into the muscle was usually followed by a connective tissue hyperplasia. In a great number of cases, although marked anatomical changes were visible in the heart, it was impossible to determine these changes during life, by auscultation, careful examination of the pulse, or any other of the ordinary clinical methods. M. G. SEELIG.

ABSTRACTS OF CURRENT LITERATURE

DEPARTMENT OF OBSTETRICS

UNDER THE CHARGE OF

C. S. Bacon, M. D. — Ralph Waldo Lobenstine, M. D.
Heliodor Schiller, M. D. — C. G. Grulee, M. D.

Placenta Prævia. Dr. Otto Pankow. *Zeitschrift der Geburtshülfe v. Gynäkologie*, b. lxiv, h. 2.

In order better to understand the pathology of placenta prævia, Pankow again draws attention to the fact that the uterus must be regarded as consisting of three sections, namely, body, isthmus, and cervix proper. The question as to the exact boundaries of the isthmus has aroused great discussion. In the light of the best modern anatomical and histological research, the isthmus is regarded as a distinct entity and not merely as a part of either the cervix or body of the uterus. The function of the body of the uterus, under normal circumstances, is to afford a proper site for the development of the placenta. The isthmus affords nourishment to the membranes; its mucosa shows marked decidual changes. The cervical portion of the uterus does not normally afford attachment or nourishment either to the placenta or membranes and consequently shows no decidual changes.

Under abnormal conditions, however, the isthmus, or at least a portion thereof, may become the site of implantation of the placenta. When the placenta actually derives some of its nourishment from the cervical tissue, it is called a true or primary "placenta prævia cervicalis." Where the cervix is overlapped by "placental tissue" which does not have its attachment directly in the cervical tissue, the overlapping is due to the development of a tongue-like formation, from a placenta situated in the isthmus. This condition is called a "secondary cervical placenta prævia." Inasmuch as the "mucosa" of the isthmus responds less actively than that of the fundal region to a decidual reaction, the placenta is frequently found to be relatively thin and markedly expanded. Should the decidual reaction in this isthmic portion be great the villi will penetrate deep into the muscle bundles of the uterine wall, almost to the peritoneal surface, as in an extrauterine gestation.

As a result the naturally thin uterine wall of the isthmus loses its elasticity and its power to contract. At the time of delivery the placenta may be difficult to extract; the uterine wall being thinned out, is very likely to tear, and having lost much of its elasticity, post-partum hæmorrhage is greatly to be dreaded. The placenta may be so adherent that it can only be separated with the greatest effort and with much loss of blood. The cervical tissue, moreover, owing to the increased vascularity and possibly deep implantation of villi, becomes exceedingly friable and may give rise to severe lacerations.

Even after the delivery of the patient, and even if the uterus has been properly tamponed, the patient may continue to bleed and may bleed to death, because of the fact above mentioned, of the loss in elasticity and contractility of the isthmic segment.

Inasmuch as all the serious complications arise from the primary fact that the placenta has an abnormal attachment in the lower segment of the uterus, instead of in the fundal region, it seems to Pankow, that the indication is to try to avoid interfering with this lower segment, during the actual delivery. He believes that the best way to accomplish this, is by abdominal Cæsarean section. By the latter method both maternal (7–8 per cent) and fœtal (70–80 per cent) death rates may be improved. In the operation, if the fundal region is incised and the wound properly sutured, the danger of a subsequent hæmorrhage is slight. Hypodermics of ergotol should be given before the operation.

Pankow presents eight cases of abdominal Cæsarean section for this condition. Seven of this series were operated upon under spinal anæsthesia.

The Pfannenstiel incision was used both for the abdominal wall and uterus. The placenta and membranes were always removed directly after the delivery of the child, and in only one case was there any great hæmorrhage. In this case a tamponade was used, which was removed, however, before the complete closure of the wound in the uterus.

Convalescence was rapid and satisfactory in all eight cases, both for the mothers and their infants.

In closing his monograph, Pankow states that the above treatment by abdominal Cæsarean section is not indicated in those cases in which the cervix is practically fully dilated. In these cases, a version is performed and the child slowly extracted, when possible. The placenta and membranes are then manually removed. *If despite hot intrauterine irrigation, massage and tamponage, the patient continues to bleed, a rapid supravaginal hysterectomy should be done.*

The treatment seems very radical, but it will undoubtedly save some lives.

In those cases of placenta prævia which are either probably or surely infected at the time of delivery, either a Buxom-Hicks version or a vaginal hysterotomy (anterior) should be performed.

Ralph Waldo Lobenstine.

Abdominal Cæsarean Section as Performed at the Society of the Lying-in Hospital of the City of New York, with an Analysis of 186 Cases. Ross McPherson. *Bulletin of the Lying-in Hospital of the City of New York*, 1908.

After a brief outline of the indications and the technique of the operation, McPherson reports that in 186 cases operated on in the past 18 years there were 30 deaths, a mortality of 16.15 per cent. Of these three died of post-partum eclampsia, six of pneumonia, one each of suppression of the urine, shock following low rupture of the uterus before admission, nephritis, pulmonary embolism, carcinoma, intestinal obstruction, acute dilatation of the stomach, asphyxia from anæsthetic, paroplegia, and one unaccounted for, two of shock, and nine of septic peritonitis.

This report compares very unfavorably with that from the Schauta clinic in Vienna, where in the past ten years in 116 cases of Cæsarean section there has been a mortality of only 3.4 per cent.

C. G. Grulee.

Goiter in the New-born. (Le Goitre chez le nouveau-né.) Fabre et Thévenot. *Rev. de Chirurg.*, 1908, No. 6.

The reported cases of goiter in the new-born are not numerous. The authors have been able to collect nearly one hundred and thirty cases. It is difficult to be precise as to the age frequency of goiter. A systematic examination of the neck of new-born children is necessary. It is probable that many cases of goiter in the adult date from birth. In goiter of the new-born, heredity seems to be an important etiological factor, but the mode of action of heredity is undetermined. It may be that glandular alteration is produced by germs conveyed from the mother. Syphilis and tuberculosis have been incriminated, but without positive proof. It is also probable that the cause of the goiter is the unsuitable water absorbed by the mother. Factors acting during intrauterine life, obstetrical factors, such as face presentation, associated with hyperextension of the neck, compression of the head during parturition, have by some been thought to have an etiological importance in the production of goiter. Among the predisposing causes are mentioned the lacunar fœtal circulation, which prepares the soil for congestive goiter.

Anatomically the lesions may affect a part or the entire gland. Usually we are dealing with a parenchymatous or vascular goiter, rarely with a fibrous, cystic, or adenamatous goiter.

Clinically, three varieties can be distinguished:

1. The fulminating form, which is characterized by sudden asphyxiation. The child has barely escaped from the maternal passages when it begins to show signs of asphyxiation of cyanosis. Death occurs in a few minutes. In these cases the tumor is not very voluminous but strangulates, ring-like, the trachea, or flattens it against the vertebral column.

2. The grave form, characterized by dyspnœa, continuous or intermittent. The patient struggles for breath, is cyanosed, has stridulous and difficult breathing.

3. The benign form, in which the functional disturbances are mild; after crying, after straining, slight dyspnœa is present. The tumor is the predominating symptom.

The diagnosis is easy if the tumor be accessible to palpation. In the absence of a palpable swelling it is necessary to eliminate dyspnœa and asphyxia due to the presence of mucosites in the larynx or to hypertrophy of the thymus.

The treatment should be prophylactic and curative. The pregnant woman should drink boiled water and use iodine in some form. When the goiter exists, the new-born is submitted to the thyroid treatment. In the presence of the symptoms of suffocation, perform an exothyropexy or isthmectomy.

Aimé Paul Heineck.

The Bacteria of the Puerperal Uterus, with Especial Reference to the Presence of Hæmolytic Streptococci. A. W. W. Lea and E. J. Sidebotham. *Jour. Obst. and Gyn. of the Brit. Empire*, January, 1909.

After reviewing the literature and discussing the various theories, the writers describe their own study of the lochial discharge from the uterine cavity in a series of cases between the second and ninth days after delivery. Their conclusions are:

1. In a series of 58 cases in which the lochial secretion was examined between the second and ninth day after delivery, organisms were found to exist in the cervical canal and cavity of the uterus in 80 per cent of observations.

2. The organisms were mainly those which have been shown to be present in the vaginal secretion during pregnancy. There is, however, considerable evidence to show that organisms also ascend from without during the early days of the puerperium.

3. The course of the puerperium was, in the great majority of cases, entirely uninfluenced by the presence of organisms.

4. Streptococci were cultivated in 20 per cent of cases, and frequently showed marked power of hæmolysis.

5. The presence of hæmolytic streptococci in the vaginal or uterine secretion cannot, in itself, be regarded as an indication of the existence of infection.

Carey Culbertson.

BOOK REVIEWS

THE STEREO CLINIC. By Howard A. Kelly, M. D. Published by the Southworth Company, Troy, N. Y.

The invention of the stereoscope by Wheatstone in 1838 was not the result of accident but the product of a train of sagacious reasoning by which the sources of our appreciation of magnitude and distance were submitted to experimental tests. The ordinary photograph is recognized as a flat surface, but looked at through the stereoscope the mind is acted on by the suggestions furnished by perspective, chiaroscuro, etc., and after a little the details start into relief and possess the solidity of a model.

Surgeons have long been conscious of a want in the way of illustrating their operations not as yet perfectly met by flat illustrations however admirably done. If some plan could be devised by which structures could be seen in relief as at the operation itself, it would greatly enhance the teaching value of the method. The stereoscope, I think, meets the want and offers an ideal solution of this question. In a stereoscopic picture (a stereogram) of a surgical operation, we have perfect natural relief, and an untouched presentation of the subject, free from all error or bias of interpretation. *The stereogram has an extraordinary value as a teaching agency:* to a surgeon who wishes to review an operation before doing it; to one who is not familiar with the particular technique and yet wishes to see it actually portrayed before he tries to imitate it; and it is of the utmost value to students who cannot always see well what is going on when at a clinic. Dr. Kelly says: "*These pictures I myself consider as much clearer than any descriptive text.* With each series of pictures there is not only provided the necessary text descriptive of the steps of the operation, but there is also added such clear practical analysis of the subject in hand in its broader bearings as operators such as J. B. Murphy are accustomed to give who operate and teach at the same time."

It is interesting to note in the earliest printed medical works how attempts have been made by woodcuts and engravings to show operations, but the artists because they were artists and not in sympathy with the subjects could not restrain themselves to realities but crowd the picture with bystanders in laced coats and full-bottomed wigs; the operator himself is content to direct proceedings and does not even take off his coat, while the nurse turns away her head in disgust as she holds a bowl to catch the blood. Even the fine drawings by the brothers Bell and other surgeons only give one picture to illustrate pages of description, and the modern volumes with their hundreds of illustrations cannot give the whole of one operation, yet in such volumes the suburban practitioners see far more than they often see of major operations, for time and money are often lacking for a journey to town and it cannot always be guaranteed that a patient will obligingly require the operation desired to be seen while the visitor is attending the clinic. Moreover, the operating room may be inconveniently crowded and hasty notes conjoined with the most retentive, studious observation cannot conjure up a complete picture again when the operation is over. There are no *encores* in an operating theatre and what is once done has forever disappeared.

It is evident to anyone examining these "stereo clinic" pictures and following one of the operations through from start to finish, that the stereoscope, in making these views, has been placed in a position at the clinic of the most favored visitor, that is to say, the instrument has been brought to within four feet or less of the field of the operation, while the operator has obligingly put the subject in the best possible light to display the details of his technique; at the same time stepping to one side himself so as not to obscure the view while the picture is being taken. These conditions have been observed not only in the making of one or two photographs, but throughout the entire series, giving them an additional peculiar value as records of the work of our most eminent surgeons, which we are glad to see perpetuated for the generations to come. It is also evident that Dr. Kelly, in taking these pictures, has found it necessary to learn first of all to dramatize an operation, that is to say, to present it in a series of distinct pictorial steps which when taken all together cover the entire technique in all its essential details from beginning to end. There is large room here, of course, for the display of judgment on the part of the technician who is getting up this series of realistic pictures, in determining what to leave out as well as what to include, and it is just here that personal surgical skill and experience are of value, we might say, indispensable.

In using the stereo clinic the doctor sits at his own desk and leisurely studies as long and as often as he likes, an operation which has been performed some hundred miles away; each step explained by the text as the pictures bring out all the details.

To some of the leading surgeons over the world the serious difficulties of successful stereoscopic work were lost in sight of its possibilities. Neisser and Küstner in Breslau, Bumm, Watson Williams in England, Camescasse and Lehman in Paris, Gwilym Davis and Wilmer Krusen in Pennsylvania, and the Edinburgh Stereoscopic Anatomy readily took up an idea which had been in the air for some time, but had never taken form except in a "series of medical photographs" or somewhat jerky and wretchedly unsatisfactory "moving picture" exhibitions. These attempts were not

all we might wish for, so we are ready to greet with pleasure and enthusiasm this present realistic series of surgical operations by our best surgeons, shown in relief with all the circumstantial reality of the clinic at which they were taken, and we confess that in looking them over we find that a pleasant surprise has awaited us. Various other attempts in the past have been notably unsuccessful, some artists having confined their attention exclusively to pathological materials, not considering the living body a fit subject for their work, on account of the presence of blood, the red color of the tissues making them difficult of differentiation, and the movements of the body inseparable from any but the briefest exposures. Where operations have been shown in some of these series, the under exposure is manifest in the black, unsatisfactory pictures, with notable absence of the details so essential in the teaching of technique. In other instances the cadaver has been used, and this is always evident in the dry, more or less board-like appearance of the parts, so different from the living tissues and repulsive to the surgeon as a medium of instruction.

We shall look with interest to additions to this set, of the radical breast operation, operations upon the throat, upon the joints, and elsewhere.

With Dr. Kelly the initial idea was to illustrate his own personal work and that of some of his confrères in Baltimore, but this idea has outgrown the swaddling clothes of first intentions, and journeys have been taken far afield to gather pictures of leading surgeons at work in their own clinics on special operations, and greater still is his plan of visiting foreign clinics and making visible in America the skillful surgery and varying methods to be seen in Europe. Long years ago young American doctors spent much time — often six weeks — crossing to Europe to study, and even now the real student knows the advantage of going abroad, but often lacks leisure or funds. To such the purpose of Dr. Kelly will bring a certain measure of help. There is pleasure in seeing the great surgeons, even through the stereoscope, especially their skillful hands, and due prominence is given to gratifying this desire for the human side.

By means of the cliniscope provided by the pubishers, from 10 to 50 pictures, nearly life size, of each operation can be seen with wonderful vividness, the sutures and needles and even the hairs on the hands of the surgeon standing out with a reality almost uncanny.

And to this must be added the advantage of reading, or rather perusing, the great surgeon's lecture delivered perhaps at the time in his own tongue or in very broken English to the bewilderment of the visitor reared on Ollendorf and French as it is (not) spoken.

In another review individual work will be spoken of but at present the plan and its development has been touched on. As to the general get up of the volumes, they have nothing to annoy the man who hates books with common paper and backs starting after a month's using. Everything about them is plain, strong, and good, the pictures, each single one, being the choice from a number of others rejected for a small defect which to the practiced eye would seem a big one and cast a suspicion of probable carelessness on the whole volume.

ROTUNDA PRACTICAL MIDWIFERY. By E. Hastings Tweedy, M. D., F. R. C. P. I., Master of the Rotunda Hospital, and G. T. Wrench, M. D., late assistant Master. London: Oxford University Press, 1908.

In this new work on obstetrics the authors frankly state in the preface that their efforts are not designed to compete with the many treatises on midwifery already extant but rather to afford the general practitioner a concise guide in the elucidation of the many difficulties confronting him. The present system of study in England, similar in this respect to that in the United States, has produced men with considerable theoretical but a small amount of practical knowledge of obstetrics. It is for this class of physicians that this book has been written. In its general plan the work does not differ greatly from the conventional text, except that much theoretical matter is omitted. Thus, the normal pelvis is described under presentations and mechanism, whereas the contracted pelvis is more completely discussed in a chapter by itself. The signs and diagnosis of pregnancy are considered in the first chapter, the next four treating in turn of the minor ailments of gestation, the obstetrical outfit, the conduct of normal labor, and the care of the normal puerperium. As is well known, at the Rotunda the patient is examined in the dorsal position but delivered in the lateral. The outfit for the out-patient service is entirely adequate, though not elaborate, and would serve excellently in our own country.

Part two includes the abnormalities of pregnancy, those due to separation of the ovum and other conditions resembling these clinically; those due to toxæmia; and those due to displacements, hydramnios, tumors, and general systemic diseases. The subject of abortion is particularly well treated, many extremely practical points being presented clearly and definitely. Vaginal tamponade is the "Rotunda treatment" for accidental hæmorrhage, as it is still called, and version for placenta prævia in practically all cases, though vaginal section is described in considering the former complication. In eclampsia the treatment is explained in the following concise and didactic manner:

"We do not advocate accouchment forcé in any form. We wait until the os is sufficiently open and the head fixed enough to apply forceps, or until the os is sufficiently open to deliver as a breech." Morphine is given and the usual eliminative procedures employed. As a defense of this treatment the authors simply point to their own statistics, a mortality of 27 per cent before 1892 and of 16.4 per cent up to 1906. Complete total hysterectomy on diagnosis is the treatment advised in malignant disease of the uterus.

Abnormal labor is discussed under the chapter headings of presentations and mechanisms; abnormalities on the part of the fœtus, on the part of the uterus, on the part of the pelvis, and of the third stage; and obstetrical operations. Mechanism of normal labor, being one of the most fundamental and, therefore, im-

portant subjects considered, is described too briefly, so briefly indeed, as not to impress upon the novice or amateur its relative value to the subsequent discussion. The mento-posterior position is not only described but illustrated by a diagrammatic drawing.

In rupture of the uterus laparotomy is deferred as far as possible, the conservative method being employed first in every case. More discussion is given to the pelvimetry of the contracted pelvis than to any other subject. Müller's method of inducing labor (after the seventh month) when the child's head is pushed into the pelvic brim with difficulty, has been adopted by the Rotunda. Induction of labor is brought about with the bougie according to Krause. Pubiotomy is advised where the true conjugate is between $2\frac{1}{4}$ and $3\frac{1}{4}$ inches. The recommendation to put the unwashed hand into the uterus in case of sudden and severe post-partum hæmorrhage is most unfortunate in a manual or text-book, particularly in this day of rubber gloves. The same error is made a few lines later where the reader is told not to waste time cleansing the vulva. In our best American practice sterile gloves are always ready and the external genitalia are not allowed to become soiled during the third stage. Again, the use of ergotin hypodermatically is mentioned late, where we would have employed it much earlier. The routine use of ergot is not in force at the Rotunda. Iodoform gauze is chosen where intrauterine tamponade is indicated.

In operative work the Barnes forceps, with Neville's axis-tractor, is used, and the patient is placed in the lateral position. Hence the technique of the operation is altogether different from ours. The admission that the operator may first administer the chloroform and then perform the forceps extraction is, in our opinion, very questionable advice, and, in our out-patient maternity services, such a method would not be tolerated.

On the other hand, attention is called to the fact that indications for Cæsarean section must be recognized early so that the operation may be undertaken before the patient becomes exhausted. This is excellent advice, not widely enough followed in America, where many obstetricians are under the influence of the ultra-conservative German school. The chapters on the abnormal puerperium are excellently considered, that portion devoted to sepsis being clear, concise, and thorough. The bacteriology is well worked out and the treatment virtually that employed by us; acute general peritonitis, however, is never operated.

The insanities of the reproductive period is taken up first under part fifth, and the last three chapters are given over to a rather full discussion of the baby, its birth injuries, asphyxia, breast and artificial feeding, and the commoner complications of early life. It is a distinct pleasure to find these subjects treated of so ably in a work on obstetrics,— where such essential topics are invariably slighted or entirely omitted.

Altogether, this work is a most creditable addition to obstetrical literature, and will be particularly acceptable to that host of physicians on this side of the Atlantic who have pursued post-graduate study at the Rotunda. The volume is of convenient size and a fair example of all publications bearing the Oxford imprint.

CAREY CULBERTSON.

A SYSTEM OF OPERATIVE SURGERY. By Various Authors. Edited by F. F. Burghard, M. S., F. R. C. S. In four volumes. Volume I. London: Henry Frowde and Hodder & Stoughton. Oxford University Press. 1909.

Great as have been the advances made in surgery during the last fifteen years, there is no direction in which they have been more noticeable than in the elaboration of those comparatively small but important details of operative technique which do so much to insure a low mortality and a successful result.

These improvements have been developed simultaneously throughout the whole of the vast field covered by modern surgery, and it has become increasingly difficult for any single writer to deal with such an important subject as operative surgery in an authoritative and efficient manner. The scope of the subject is so wide that it is difficult to insure that the work when published shall be thoroughly up to date, while a second and even greater difficulty is for any one, however great his ability and experience, to deal equally exhaustively and authoritatively with all of the many branches of which he would have to treat.

To avoid both of these difficulties and thus to make sure that the work shall reflect faithfully the present position of British operative surgery, in Burghard's System of Operative Surgery, issued by the Oxford Press, which is now before us, the plan has been adopted of securing the co-operation of a number of prominent British surgeons. Each writer deals with a branch of the subject in which he has had special experience, and upon which, therefore, he is entitled to speak with authority.

The first volume of this four volume work produces the impression of unusual worth. The contributors and their subjects are: C. B. Lockwood, F. R. C. S., The Principles and Technique of Wound Treatment; Captain J. W. H. Houghton, R. A. M. C., The Methods of Local Analgesia; Frederick F. Burghard, M. S., F. R. C. S., Amputations, and T. P. Legg, M. S., F. R. C. S., Plastic Surgery. This volume represents the highest attainment of the book maker's art in typography, illustrations, paper and binding, being no exception to the satisfactory work usually issued by the Oxford Press.